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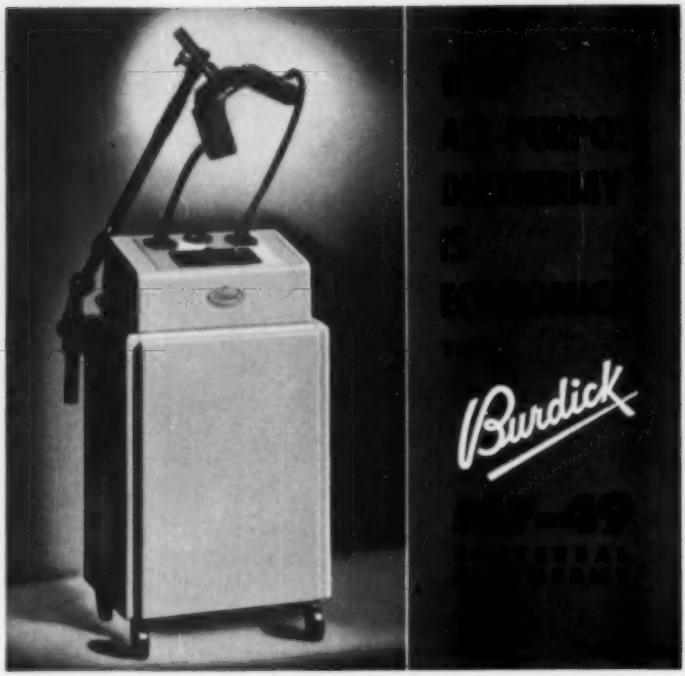

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EDITOR OF THE MONTH

EARL C. ELKINS, M.D.
Rochester, Minn.

Printed in U.S.A.

Section on Physical Medicine and Rehabilitation

Southern Medical Association

St. Louis, Missouri

Wednesday, November 15, 1950, 2:00 to 5:00 p. m.

1. **Chairman's Address.**
   WALTER J. LEE, M.D., Richmond, Virginia.

2. **A Report on Three Years' Activities in the Veterans Administration TB Center.**
   BATHHURST B. BAGBY, M.D., Chief, Physical Medicine Rehabilitation Service, Veterans Administration Hospital, Oteen, N. C. (Ashville).

3. **Title to be announced.**
   SEDGWICK MEAD, M.D., Assistant Professor of Physical Medicine and Head of Division of Physical Medicine, Washington University School of Medicine, St. Louis, Missouri.

Intermission

4. **Title to be announced.**
   DONALD L. ROSE, M.D., Associate Professor of Physical Medicine, University of Kansas School of Medicine, Kansas City, Kansas.

5. **Guillain-Barre Syndrome.**
   ODON F. VON WERSSOWETZ, M.D., Chief, Physical Medicine Rehabilitation Service, Thayer Veterans Administration Hospital, Nashville, Tenn.

6. **Title to be announced.**
   ALVIN B. C. KNUDSON, M.D., Chief, Physical Medicine Rehabilitation Division, Department of Medicine and Surgery, Veterans Administration, Washington, D. C.

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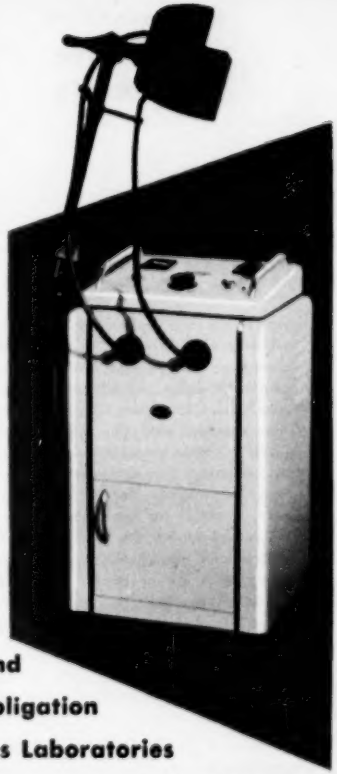

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THE INFLUENCE OF MICROWAVE DIATHERMY ON THE SWELLING AND TRISMUS RESULTING FROM ODONTECTOMY *

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KHALIL G. WAKIM, M.D.
Section on Physiology, Mayo Clinic
STANLEY A. LOVESTEDT, D.D.S.
Section on Dental Surgery, Mayo Clinic
and
FRANK H. KRUSEN, M.D.
Section on Physical Medicine, Mayo Clinic
ROCHESTER, MINN.

The recent advances in microwave therapy may provide an effective adjunct to the care of the patient after removal of impacted third molars. The usual sequelae of the removal of impacted third molars, manifested as swelling and trismus, have received clinical attention, but scanty information is available concerning the extent, duration and severity of these conditions. Physical agents, such as heat and cold, have been used empirically to alleviate the postoperative symptoms.

This study was carried out in order to observe and record as accurately as possible the degree of swelling and trismus which follows removal of impacted third molars and to evaluate the results of a new kind of heat treatment, namely, microwave diathermy, which has been used on patients who have undergone odontectomy of the third molar.

With the advent of the use of microwaves in heating living tissues, it was thought that this new therapeutic agent might be beneficial in postoperative oral surgical conditions because of the ability of microwaves to provide a penetrating and focusable heat energy to tissues about the jaws. Prior to this study microwave therapy was used a few times and apparently alleviated the swelling, trismus and pain which follow certain oral surgical procedures, such as the removal of impacted third molars.

Swelling and Trismus After Odontectomy

The swelling that follows the surgical removal of an impacted third molar is due to the inflammatory edema which is produced by the outpouring into the tissues of intravascular fluid as a result of the action of irritants which increase the permeability of capillaries.[1] The fluid produces a temporary thickening of the cheek and tissues contiguous to the third molar region.

The cause of the trismus, or the inability to open the jaws to the fullest extent, which is an invariable sequela of the removal of impacted third molars, is not known. It is most likely that the direct action of the inflammatory exudate in and around some of the muscles of mastication is at least partially

* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 7, 1949.

* Abridgment of thesis submitted by Dr. Royer to the Faculty of the Graduate School of the University of Minnesota in partial fulfilment of the requirements for the degree of Master of Science in Dental Surgery.

1. Bell, E. T.: A Textbook of Pathology, ed. 6, Philadelphia, Lea & Febiger, 1947.

responsible. Smart[2] discussed delayed resorption of inflammatory exudates in muscle, a condition which produces stagnation of blood and lymph and may be the cause of the formation of adhesions in muscle. Muscle fibers, consequently, may be bound together and to the supporting connective tissue, thus causing interference with relaxation of the muscles.

Fig. 1. — Technic of taking measurements of swelling. (*a*) Intra-oral placement of straight arm of caliper when taking the control measurement; (*b*) closure of anterior teeth on straight arm of caliper and curved arm adjusted to touch the cutaneous surface of the cheek; (*c*) technic of completing measurements of swelling on the first postoperative day.

Review of the Literature

During the past two years, when microwave diathermy has been used clinically, it has been shown that microwaves can heat human and animal

Fig. 2. — Technic of measuring distance between edges of maxillary and mandibular central incisors, to indicate degree of trismus after removal of impacted third molars. The mouth is opened maximally.

2. Smart, Morton: The Rationale and Technic of Treatment by Graduated Muscle Contractions, Brit. J. Phys. Med. 8:87 (Oct.) 1945.

tissues effectively.[3] Since many oral surgeons favor the use of heat the day following removal of impacted third molars,[4] it was thought that the application of microwaves to the jaw during the postoperative course of third molar odontectomy might be beneficial in alleviating swelling and trismus. It provides a method by which tissues about the jaws can be heated deeply without application of heating apparatus. It may reduce swelling and trismus after third molar odontectomy by causing a rise in the temperature of the tissues, an increase in local circulation, an increase in exchange of fluid and an increase in the rate of lymph drainage.[5] Denkman[6] concluded that after twenty minutes of exposure to short wave diathermy the increase in temperature causes relaxation of muscles. The local heat produced in the tissues by exposure to microwaves is known to bring about an increase of venous return and a vasodilation through local reflex mechanisms and direct metabolic effects.[5] Heat is thought to increase the metabolism of tissues. This would tend to accelerate the budding of new capillaries, increase fibroblastic activity and accelerate the healing of the wound. Therefore, it might be postulated that heat would be of value in the more rapid alleviation of swelling and trismus by increasing the exchange of fluid, thereby reducing the amount of edema fluid and preventing organization of the exudate in the tissues.

Procedures and Materials

The procedures followed in this study were designed to determine the effectiveness of microwave therapy on the swelling and trismus which in varying degrees follow removal of impacted third molars. Thirty-five patients with bilaterally impacted third molars for which removal was indicated were selected for study. In 19 of these cases the extent of the operation on the two sides was approximately the same, and reasonably complete observations were made in these cases. The bilaterally impacted third molars were removed from one side at a time. In nearly every instance both maxillary and mandibular third molars on one side were removed at each operation. As nearly as possible all factors which would alter the postoperative course of swelling and trismus were kept the same. The degree of swelling was determined in the following manner: Prior to operation a control measurement of the distance between the lingual embrasure of the mandibular first and second molars and the cutaneous surface of the cheek was taken, as shown in figure 1 *a* and *b*. Postoperative swelling produces an increase in this distance. After the odontectomies this measurement was repeated daily (fig. 1 *c*) so far as possible until all swelling had subsided. Therefore, to determine the degree of swelling in millimeters, the preoperative measurement was subtracted from the postoperative measurement.

The degree of trismus was determined by measuring the distance between the incisal edges of the maxillary and mandibular central incisors when the mouth was opened maximally (fig. 2). A preoperative control measurement was taken in every case. Postoperative measurements were taken as often as possible until all trismus had disappeared. The postoperative reduction in the distance between the edges of the maxillary and mandibular central incisors indicates the degree of trismus. Therefore, to determine actually and accurately the degree of trismus in millimeters, the postoperative measurement was subtracted from the preoperative control measurement.

Microwave diathermy was administered on the first four postoperative days on the side of the jaw previously selected for treatment. Averages of the degree of swelling and trismus in millimeters for each of the first seven postoperative days on the treated side were then compared with similar averages for the untreated sides. The source of microwave energy used in this study was a generator with a multicavity magnetron tube which produced continuous electromagnetic waves of wavelength of about 12

3. Krusen, F. H.; Herrick, J. F.; Leden, Ursula, and Wakim, K. G.: Mirokymatotherapy: Preliminary Report of Experimental Studies of the Heating Effect of Microwaves ("Radar") in Living Tissues, Proc. Staff Meet., Mayo Clin. **22**:209 (May 28) 1947.

4. Moose, S. M.: The Rational Therapeutic Use of Thermal Agents With Special References to Heat and Cold, J. Am. Dent. A. **24**:185 (Feb.) 1937.

5. Horvath, S. M.: Fundamentals of Physical Medicine of Interest to General Practitioners, J. A. M. A. **136**:605 (Feb. 28) 1948.

6. Denkman, Dorothy: Quoted by Tuttle, W. W., and Fitts, Lucille: The Effect of Heat Produced by Short Wave Diathermy on the Activity of Muscle, J. Lab. & Clin. Med. **29**:689 (June) 1944.

cm. at an oscillating frequency of 2,450 megacycles per second.[7] A 4 inch (10 cm.) hemispherical director was used for transmitting the microwaves from the coaxial

Fig. 3. (a) Application of microwaves to the jaw after third molar odontectomy. Note the cabinet housing the microwave generator, the coaxial cable and the small hemispherical director. The instrument in the foreground is the thermistor; (b) relationship between the hemispherical director and the face.

cable onto the area of the tissues contiguous to the site of odontectomy. The patients were seated in a dental chair (fig. 3*a* and *b*), and the small hemispherical director was adjusted so that the zone of maximal heat energy was in the area of greatest swelling.

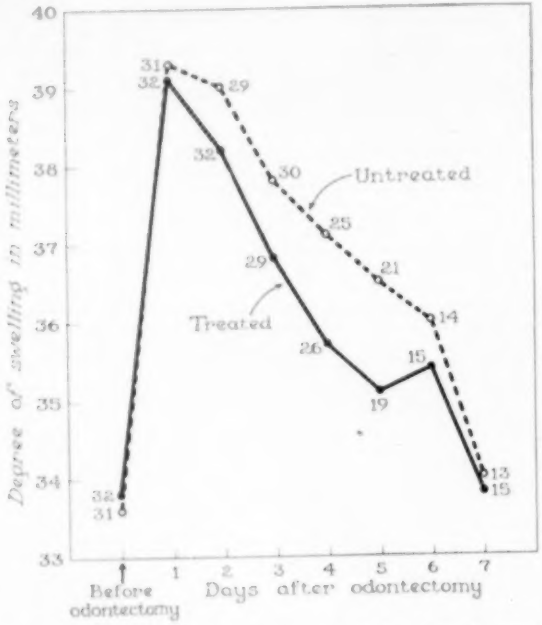

Fig. 4. — Averages of the daily measurements of the distance between the lingual embrasure of the mandibular first and second molars and the cutaneous surface of the cheek to determine the degree of swelling on the untreated and treated sides. Data on 35 patients before and after third molar odontectomy in 35 patients is shown. Arabic numbers on curves indicate numbers of patients measured.

Exposure for twenty minutes each day was used in all cases. The distance between the director and the cheek was carefully maintained at 5 cm. throughout the period of heating. The power control was adjusted so that the output of the machine would be

7. The Microtherm Operating Manual. Raytheon Manufacturing Company, Waltham, Mass., 1947.

maintained at 80 per cent of the maximal power output. Thus the power output was carefully maintained at 100 watts for the entire twenty minute period of heating.

In some cases temperatures of skin and intra-oral mucosa which were exposed to microwaves were recorded by the use of a thermistor.[8] A control temperature of the skin or mucosa was taken before heating. The temperature of the same side was again recorded within ten seconds after the termination of the period of exposure to microwaves when the generator was turned off.

In order to be able to appraise microwave therapy no other thermal agents were used on the jaws of the patients included in this study after removal of impacted third molars.

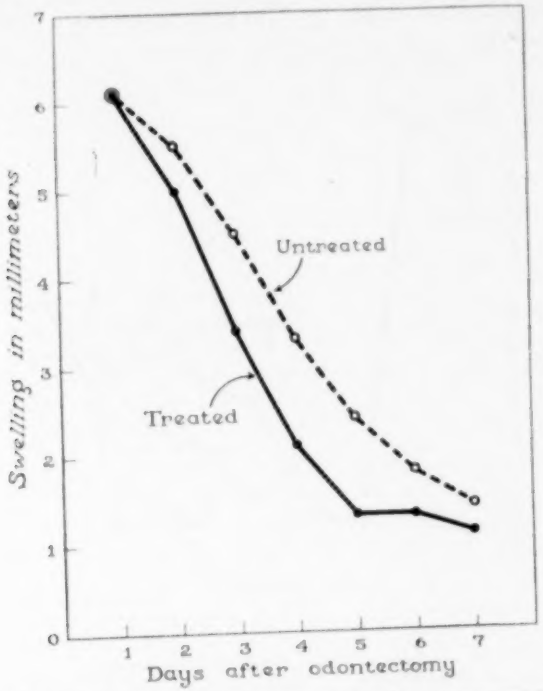

Fig. 5. — The average degree of swelling of 19 patients as determined by subtracting the preoperative from the postoperative measurement of the distance between the lingual embrasure of the mandibular first and second molars and the cutaneous surface of the cheek measurement.

Results

The data obtained by measuring the thickness of the cheek and jaw to indicate the degree of swelling on both the untreated and the treated sides are given in figure 4. For the sides not treated the average of this distance was 33.6 mm. before operation. The average distance increased to 39.3 mm. on the first postoperative day, then decreased to 37.8 mm. on the third postoperative day and gradually declined on each successive postoperative day until the average of the seventh day was 34.0 mm.

The average preoperative control measurement for the sides to be treated was 33.8 mm. This increased to 39.1 mm. on the first postoperative day.

8. Becker, J. A.; Green, C. B., and Pearson, G. L.: Properties and Uses of Thermistors — Thermally Sensitive Resistors, Elec. Engin. (Nov.) 1946.

The average decreased to 36.8 mm. on the third postoperative day and to 33.8 mm. on the seventh postoperative day.

The averages of the preoperative measurements were almost the same in both the untreated and the treated series, namely, 33.6 and 33.8 mm., respectively. The average values for the untreated and the treated series were also practically identical on the first postoperative day, namely, 39.3 and 39.1 mm., respectively. However, the average values represented by the measurements of swelling in the treated series are somewhat lower than the average values for the control series on the second, third, fourth, fifth and sixth postoperative days (fig. 4). The greatest difference in the average of

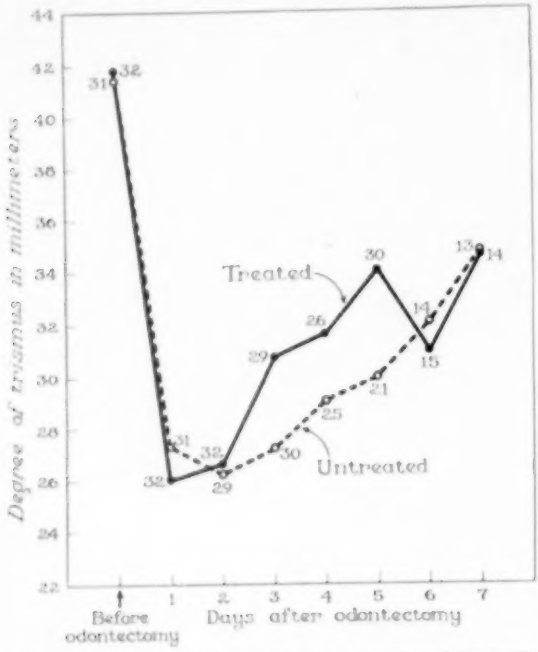

Fig. 4.—Daily averages of the distance between the edges of the maxillary and mandibular central incisors when the mouth is opened maximally. The influence of microwaves on the degree of trismus following third molar odontectomy in 35 patients is shown. Arabic numbers on curves indicate numbers of patients measured.

the measurements of swelling between the treated series and the untreated series appeared on the fifth postoperative day. It can be observed that the average of the measurements of swelling of the sides treated was greater on the sixth postoperative day than the average value shown for the fifth postoperative day. After careful study of this observation it seems to us that it is probably due to the fact that only those patients who had severe swelling returned for measurements on this day. The averages of the measurements of swelling were approximately the same, however, for the two sides on the seventh postoperative day.

The averages of degrees of swelling in millimeters on the untreated and the treated sides in 19 patients who were seen sufficiently often so that reasonably complete data were obtained for the first seven postoperative days

are given in figure 5. The average severity or degree of swelling was the same for the sides treated and not treated on the first postoperative day. By the second postoperative day, microwave therapy had caused a slight reduction in swelling, as the average swelling was 5.0 mm. on the side treated and 5.5 mm. on the side not treated. However, the difference in the average degree of swelling on the sides treated and not treated became greatest on the fifth postoperative day, when the average swelling was 1.3 mm. on the treated side and 2.4 mm. on the side not treated. Swelling had almost disappeared in both series by the seventh postoperative day.

It is interesting to note the number of instances in the treated and untreated series in which little or no swelling (1 mm. or less) was exhibited on any particular postoperative day. Three of the 19 patients had swelling of 1 mm. or less on the treated side on the third postoperative day. On this day there were no patients who had a swelling of less than 2 mm. on the side not treated. On the fifth postoperative day 52.6 per cent (10 of 19) of the patients exhibited approximate termination of swelling on the side treated, whereas only 26.3 per cent (5 of 19 patients) showed termination of swelling on the untreated side.

On the sixth postoperative day the swelling had disappeared in 63.1 per cent of the treated series and 47.3 per cent of the untreated series. On the seventh postoperative day 68.9 per cent of the sides treated and 63.1 per cent of the sides not treated showed swelling of 1 mm. or less.

The average measurements of trismus obtained before and after operation in the treated and untreated series can be compared (fig. 6). The average preoperative measurements for both the untreated and the treated sides were between 41 and 42 mm. The average measurement for the side not treated was 27.3 mm. on the first postoperative day and 26.2 mm. on the second postoperative day, indicating that the average distance the mouth could be opened was less (trismus was severer) on the second postoperative day. For the side treated the average distance that the mouth could be opened was greater on the second postoperative day, 26.6 mm., than on the first postoperative day, 26.0 mm. On the third postoperative day the average measurement in the treated series, 30.7 mm., was considerably greater than the average measurement for the untreated series, 27.2 mm. This difference, indicating that trismus was less severe in the treated series, continued through the fourth and fifth postoperative days. On the sixth postoperative day the average of the distance between the maxillary and mandibular central incisors when the mouth was opened maximally was less in the treated series than in the untreated series. This is due to the fact that the patients measured on this day were the ones with severest trismus. The average measurements of trismus were approximately the same for both the treated and the untreated series on the seventh postoperative day.

On the first postoperative day the reduction in the distance that the mouth could be opened maximally was 14.0 mm. when microwave therapy was not given. Trismus became severer and the reduction in this distance was 16.7 and 16.2 mm. on the second and third postoperative days, respectively. By the fifth postoperative day the degree of trismus was 12.1 mm. Following surgery and microwave therapy the average severity of trismus was 17.3, 16.7 and 13.5 mm. on the first, second and third postoperative days, respectively. The degree of trismus was 9.5 mm. on the fifth day after surgery and treatment.

The average severity of trismus is compared for the 19 patients in which conditions were sufficiently alike to justify comparison of the untreated and

treated sides in figure 7. It can here be observed that on the first postoperative day the severity of trismus as expressed in millimeters was considerably less on the untreated side, 14.0 mm., than it was in the treated series, 17.3 mm. However, after one microwave treatment the average degree of trismus for the treated series decreased to 16.7 mm. on the second postoperative day. This was nearly equal to the average degree of trismus on the second postoperative day for the untreated series, in which trismus had become severer than it was on the first postoperative day. On the third postoperative day the degree of trismus as expressed in millimeters was 16.2 for the un-

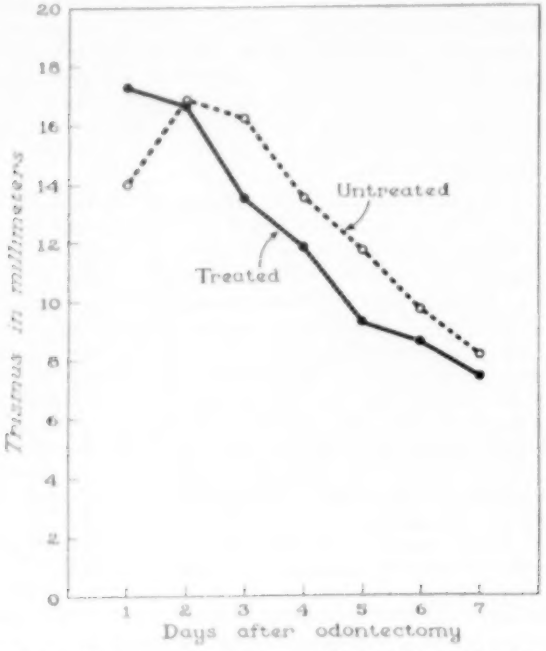

Fig. 7. — The average severity of trismus of 19 patients obtained by subtracting the postoperative from the preoperative measurement of the distance between the edges of the maxillary and mandibular central incisors when the mouth is opened maximally.

treated series and only 13.5 for the treated series. In comparing the degree of severity of trismus, the data indicated that trismus on the fourth postoperative day in the treated series was practically of the same degree as the trismus on the fifth postoperative day in the untreated series. Therefore, if equal severities of trismus are considered, the treated series was one day ahead of the untreated series. On the seventh postoperative day the average degree of trismus for the treated series was 8.7 and 6.5 mm. for the untreated series.

Temperature in the Jaws of Patients Before and After Microwave Diathermy. — The data obtained by measuring skin and intra-oral mucosal temperatures by means of a thermistor before and after microwave diathermy indicated that it was possible to raise the temperatures of the skin and intra-oral mucosa by the application of microwaves. Skin temperatures before microwave diathermy in 7 cases ranged from 28.5 to 34.9 C., with an average

of 31.6 C. before heating. After twenty minutes of exposure to microwaves the skin temperatures ranged from 32.0 to 37.0 C., with an average of 35.1 C. The average rise in temperature of the skin after heating was 3.4 degrees.

Similarly, the temperatures on the mandibular buccal mucosa and lingual mucosa adjacent to the site of extraction were determined before and after twenty minutes of irradiation with microwaves. The temperatures on the buccal mucosa before heating with microwaves ranged from 34.5 to 37.8 C., with an average of 36.8. The average difference between the control temperature and that after the heating of the buccal mucosa in the 17 cases in which it was determined was 1.1 degree. The average difference between the control temperature and the temperature after heating of the lingual mucosa medial to the extraction site in 9 cases in which it was determined was 0.9 degrees. Thus, it can be observed that the average rise in intra-oral temperature was slightly greater lateral to the site of extraction than medial to the wound.

Comment

During the course of this study as measurements were being taken and before calculations and comparisons were made, it was not apparent that microwave therapy was instrumental in the alleviation of swelling and trismus. It was not until the study ended and over-all calculations of the average degrees of swelling and trismus were computed that the differences were noted between the sides treated and not treated.

It can be stated with certainty that microwave therapy does not cause an immediate reduction of swelling or provide complete relief from the distressing symptoms of trismus. The rate of recovery of the patient when microwaves are applied to an affected jaw is not striking. However, as has been shown by the results of this study, the average severity of swelling and trismus which occur after odontectomy of third molars has been substantially lessened by treatment with microwaves. This means that some patients are helped and others are not; some may be relieved more than others.

The apparent relief from postoperative pain and soreness, especially during the actual heating period may be the most important effect of microwave therapy when applied to a painful, swollen jaw that is difficult to open. Unfortunately, it is impossible to measure accurately pain or the relief from pain. It was thought that postoperative pain might be graded, but the results of this attempt were entirely unsatisfactory.

Summary and Conclusions

The degree of swelling and trismus following odontectomy of third molars was studied in 35 patients. In order to determine the effect of microwave diathermy on the swelling and trismus, one side was exposed to microwaves and the other was left untreated after odontectomy of third molars. In these patients impacted third molars were situated bilaterally, but the removal was done one side at a time. The microwave diathermy used in all cases consisted in twenty minutes of continuous exposure to microwaves at an output of 100 watts when the director was at a distance of 5 cm. from the skin of the cheek. This treatment was given on the first four days after operation on only one side. Measurements indicative of swelling and trismus were made postoperatively on both sides of the jaw. When the averages of the measurements of the sides treated were compared with the averages of the sides not treated, the following facts were noted:

1. Swelling was less severe on the side that was exposed to microwaves

than on the side not treated during the second, third, fourth and fifth postoperative days.

2. Trismus was less severe on the third, fourth and fifth postoperative days when the jaw was treated with microwaves following odontectomy than when no microwave diathermy was applied.

An additional comparative analysis was made in 19 of the 35 cases in which the data were complete and the extent of surgical procedures on one side of the jaw of each patient was nearly equal to that on the other side. In this group of patients the average severity of swelling and trismus was less after microwave irradiation than when no microwave diathermy was applied. It was found that the differences in the severity of swelling and trismus when treatment was given and when it was not given to these 19 patients were similar to the differences noted for the 35 patients.

An average rise in the intra-oral temperature of 0.9 degree (C.) was recorded on the lingual side of the mandible in 9 cases, and an average rise in temperature of 1.1 degree on the mucosa lateral to the site of extraction was recorded in 17 cases after microwave diathermy.

The discussion of this paper will appear in a later issue of the ARCHIVES.

STERILIZATION OF WATER IN HYDROTHERAPEUTIC TANK BY UNDERWATER USE OF ULTRAVIOLET RAYS *

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As a sterilizing agent, ultraviolet radiation is rapidly occupying a more prominent place in various branches of industry, medicine and laboratory practice.

It has been used for the sterilization of drinking water and for the disinfection of swimming pools.[1] However, we could find no record of the underwater use of ultraviolet rays as a sterilizing agent in hydrotherapeutic practice.

The purpose of this study was to determine the efficacy of underwater ultraviolet rays in the disinfection of hydrotherapeutic tanks, as many of the treated patients have open lesions, often caused by bacteria or fungi.

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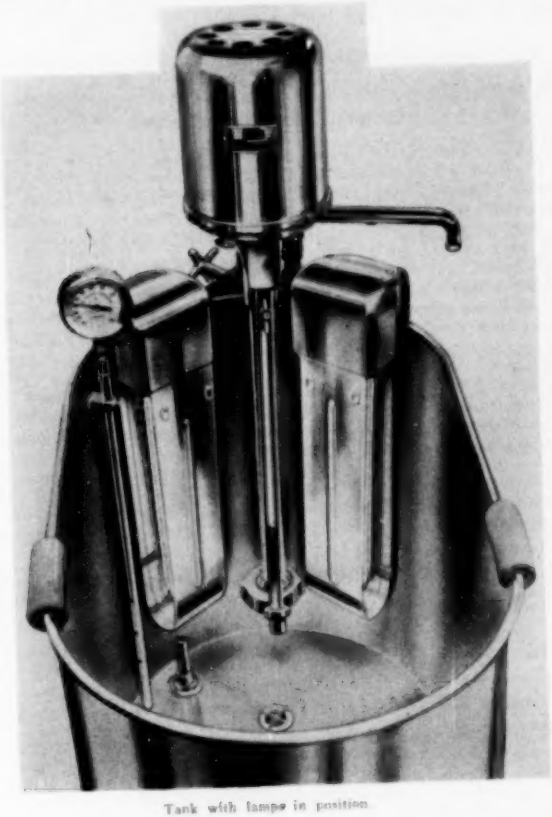
Acknowledgment is made for valuable assistance of William Knappenberger, A.B., and Poline Shubarsky, M. S.

1. (a) Ellis, C., and Wells, A.: The Chemical Action of Ultraviolet Rays, New York, The Chemical Catalog Com., Inc., 1925. (b) Ryan, W. J.: Water Treatment and Purification, New York, McGraw Hill Book Co., 2nd, 1940. (c) Frohlicher, M.: Fundamentals of Bacteriology, Philadelphia, 1945, pp. 93-95. (d) Rentschler, H. C.; Nagy, R., and Mouromeff, G.: Bactericidal Effect of Ultraviolet Radiation, J. Bact. **41**:845, 1941. (e) Hollander, A.: Effect of Long Ultraviolet and Short Visible Radiation on E. Coli, J. Bact. **46**:531, 1943. (f) Hollander, A.: Ultraviolet Irradiation as a Means of Disinfection of Air, Am. J. Pub. Health **33**:980, 1943. (g) Tanner, F. W., and Appling, J. W.: Bactericidal Effect of Ultraviolet Rays on Non-Spore Forming Bacteria and Mold Spores, Proc. Soc. Exp. Biol. & Med. **47**: 65, 1941. (g) Wells, W. F., and Fair, G. M.: Viability of B. Coli Exposed to Ultraviolet Radiation in Air, Science **82**:280, 1935. (h) Wells, W. F.: Bactericidal Irradiation of Air, Franklin Inst. **229**:347, 1940.

A new type ultraviolet lamp was hung at about the middle of each side of the hydrotherapeutic tank. The lamps are "U" shaped, 36 inches in length and 1 inch in diameter. They have a 30 watt input with the same over-all properties of emission as a standard basic type ultraviolet generator, which is a "Shortwave (2,537) Angstrom units) low pressure mercury vapor germicidal lamp." The lamp current is 0.34 amperes. The intensity is 64 microwatts, and the total emission is 5.8 watts. It is operated by connection to a standard 110/115 volts, 60 cycles, a. c. outlet. It does not have



Tank with lamps in position

a fluorescent coating on the inside, thus avoiding the hazards of poison. The life expectancy of the lamp is 2,500 hours in 3-hour cycles, with a subsequent decrease in life expectancy when used in shorter starting cycles.

First, the effect of ultraviolet rays on the usual bacterial flora of tap water in the tank was investigated. This was followed by a study of the effect of the rays on the bacteria most frequently encountered in wound infections. The micro-organisms used for this purpose were Escherichia coli, Staphylococcus aureus, enterococci, pseudoanthrax bacilli and Trichophyton mentagrophytes. Samples of water in the tank were taken before and after twenty minutes of exposure to ulraviolet rays.

When we started this investigation, certain difficulties soon became apparent. First, the normal bacterial flora of tap water was too scant to permit a reliable conclusion regarding the destructive effect of the ultraviolet rays. Second, when the tank was inoculated with test organisms most of

them could not be recovered, even when cultures were made immediately after seeding. Most of the microbes were already destroyed or weakened to such an extent that they could not be grown on artificial culture mediums. In addition, the rate of destruction varied from one experiment to another.

It became evident that before we could ascertain the effect of ultraviolet rays on bacteria in hydrotherapeutic tank water, we would have to determine to what extent the temperature, the presence of chlorine, the trisodium phosphate used for cleansing the tank and the tank water itself inhibited the bacteria.

Test experiments were set up to study the bactericidal effect of each of these factors.

General Laboratory Technic

In each experiment the test sample of water consisted of 1,000 ml. of water inoculated with 1 ml. of a 1:10 dilution of an eighteen hour broth culture of E. coli and Staphy. aureus. Samples were taken (1) immediately after inoculation of the bacteria and their thorough agitation with the water and (2) after twenty minutes of exposure in a water bath at 44 C. All tests, except those in which the effect of temperature was studied, were carried out at a temperaure of 44 C.

Duplicate blood agar plates were made with 1 ml. of undiluted water and dilutions of 1:100, 1:1000, 1:10,000 in brain-heart infusion broth immediately after inoculation and sometimes two hours after inoculation of the organism into the water.[2]

Titration of every culture by serial dilutions was carried out as follows: One-tenth milliliter of an eighteen-hour broth culture of the organism was inoculated first into a tube containing 9.9 ml. of brain-heart infusion broth, making a 10^{-2} dilution. From this, 0.5 ml. was transferred into a tube containing 4.5 ml. of brain-heart infusion broth, making a dilution of 10^{-3}. Dilutions up to 10^{-10} were made by inoculating 0.5 ml. of each previous dilution into 4.5 ml. of brain-heart infusion broth. Simultaneously, blood agar pour plates were made with 0.5 ml. of each dilution.

Plates were examined twenty-four hours after incubation and again after seventy-two hours of incubation at 37 C. The number of bacteria per milliliter of original culture was calculated on the basis of colony counts made with a Spencer Darkfield Quebec Colony Counter.

The Effect of Temperature

The effect of temperature on the growth of bacteria was studied in distilled water, tap water containing various concentrations of chlorine and dechlorinized tap water. The bactericidal action of a temperature of 37 C. was compared with that of 44 C. immediately after exposure and after an interval of twenty minutes. Table 1 is representative of the results obtained in these experiments.

Table 1.—*Effect of Temperature on the Growth of E. Coli* in Distilled Water, Chlorinized Water, Dechlorinized Water.*

Time of Sampling	Number of E. Coli at 37 C.			Number of E. Coli at 44 C.		
	In Distilled Water	In Chlorinized Water 0.1 PPM	In Dechlorinized Water	In Distilled Water	In Chlorinized Water 0.1 PPM	In Dechlorinized Water
Immediate	282,500	238,000	270,000	250,000	190,000	220,000
After 20 minutes	260,000	200,000	250,000	170,000	100,000	150,000

* Initial number of E. coli 309,000 per milliliter according to titration.

The findings showed that even the sample taken immediately after exposure to a temperature of 44 C. had approximately 20 per cent fewer recoverable bacteria than the sample exposed to a temperature of 37 C. This difference in bactericidal effect was more marked after exposure for twenty

2. The two hour interval in the text experiments simulated the time elapsing between the collection of the specimen from the hydrotherapeutic tank and its delivery to the laboratory.

minutes. More than 35 per cent of the bacteria were destroyed after exposure for twenty minutes at 44 C., while at 37 C. the diminution was about 10 to 15 per cent. The destructive effect at 44 C. was even more marked when the cholorine content in the tap water was higher.

The results following a two hour interval prior to plating showed no significant difference. Similarly, the results when Staph. aureus was used as the inoculum were not significantly different from those obtained with E. coli.

The Effect of Chlorine

Water supply is commonly treated with chlorine in order to destroy harmful bacteria. The usual chlorine demand of filtered water is 0.06 to 0.2 parts of chlorine per million parts of water, with a typical residual chlorine concentration of 0.1 to 0.2 ppm of water.

Reports[5] indicate that the bactericidal power of chlorine is most marked when free chlorine ions (Cl^+) are present in water and that this bactericidal effect increases considerably as the temperature increases.

Before determining the effect of chlorine on the test microorganisms used in our study, we first made analyses of the chlorine content of tap water.

These determinations were made by means of the orthotolidine standard colorimeter, with use of 1 ml. of orthotolidine reagent in 100 ml. of water tested. The yellow color developed in the test sample was compared with a series of quantitative colorimetric standards. The immediate appearance of a decided yellow color in the test sample was considered indicative of the presence of free chlorine ions.

These tests were made three times daily during a one month period. They showed that the concentration of chlorine in tap water varied even during a single day. The morning sample of tap water usually had a higher concentration of chlorine than the evening sample; variations ranging between 0.06 to 0.2 parts of chlorine per million parts of water were noted.

To note the effect of chlorine on E. coli, experiments were conducted with plain tap water and dechlorinized tap water. A 0.2 per cent solution of sodium thiosulfate ($Na_2S_2O_3$) was used to dechlorinize the tap water.

A representative example of the results obtained in these experiments is given in table 2.

TABLE 2 — *Effect of Chlorine on the Growth of E. Coli.**

Time of Sampling	Number of E. Coli — In Tap Water Chlorine Content PPM — 0.07	0.10	0.15	In Dechlorinized Water
Immediate	220,000	196,000	130,000	264,000
After 20 minutes at 44 C.	185,000	140,000	90,000	218,000

* Initial number of E. coli 300,000 per milliliter according to titration.

It is evident from table 2 that the survival of bacteria depended upon the concentration of chlorine in the tap water. A low concentration of chlorine did not seem to be as bactericidal as a higher concentration. Thus the number of bacteria in tap water always was lower than in dechlorinized water.

The survival rate of E. coli on immediate sampling ranged from 40 to 80 per cent, while that of Staph. aureus ranged from 60 to 85 per cent. After a lapse of twenty minutes, the survival rate of both of these micro-organisms was less.

5. Sherman and Holm: J. Bact. 7:465, 1922. Streeter, H. W.: Bacterial Changes in Chlorinated Water Filter Effluent, Public Works 64:19, 1933. Ryan, 1b.

The concentration of chlorine most frequently encountered ranged from 0.07 to 0.15 ppm of tap water. It was found that when the concentration of chlorine was higher and free chlorine ions were present, a greater destructive effect was noted. Over 90 per cent of the bacteria were killed immediately in some experiments.

These experiments showed conclusively that the bactericidal power of chlorine was directly related to its concentration and the presence of free chlorine ions.

Inasmuch as the chlorine content of tap water was found to be high at some times, this would explain the variable results obtained in primary tank experiments in which few, if any, bacteria could be recovered following inoculation of the water.

The Effect of Trisodium Phosphate

Inasmuch as trisodium phosphate was used for cleaning the hydrotherapeutic tank, it appeared that some of the destruction of bacteria which occurred might be attributable to the detergent remaining in the tank after cleansing.

In order to determine what, if any, inhibiting effect could be attributed to trisodium phosphate, 0.5 cm. of this detergent was added to 1,000 ml. of each of the following: (1) distilled water, (2) isotonic saline solution and (3) tap water. Determinations of the *p*H and chlorine concentration were made prior to and after the addition of trisodium phosphate. The findings were as follows:

	*p*H	Concentration Chlorine p.p.m.
Distilled water	6.8	0
Distilled water with Na_3PO_4	8.6	0
Saline	6.8	0
Saline with Na_3PO_4	8.6	0
Tap water	6.6	0.15
Tap water with Na_3PO_4	8.6	0.08

It is evident that the addition of Na_3PO_4 increased the alkalinity of distilled water, saline and tap water from *p*H 6.6 to *p*H 8.6.

A colony count made of the bacterial growth of each of these vehicles showed that a 0.05 per cent solution of Na_3PO_4 at 44 C., had a strong inhibiting effect on the growth of E. coli and Staph. aureus. This effect was marked on immediate contact and much higher after exposure for twenty minutes. The inhibition appeared to be more pronounced with E. coli than with Staph. aureus.

Table 3 is representative of the findings of the survival of E. coli in distilled water, tap water and saline containing trisodium phosphate.

It is apparent from table 3 that trisodium phosphate definitely inhibits the growth of E. coli in distilled water, tap water and saline. Its inhibitory

TABLE 3.—*The Effect of Trisodium Phosphate on the Growth of E. Coli.**

	Number of E. Coli					
	In Distilled Water		In Tap Water		In Saline	
Time of Sampling	With Na_3PO_4	Control	With Na_3PO_4	Control	With Na_3PO_4	Control
Immediate	14,000	235,000	80,000	202,000	10	275,000
After 20 minutes	20	188,000	7,000	161,000	0	237,000

* Initial number of E. coli 314,000 per milliliter according to titration.

effect is most marked in the presence of sodium chloride, in which only a few viable E. coli could be recovered from the sample taken immediately after inoculation and in which no bacteria were recoverable after twenty minutes of contact. In tap water the bactericidal effect of the trisodium phosphate was less marked than in distilled water. This may be attributed to the neutralizing effect of the chlorine upon the trisodium phosphate.

The Effect of Water

There are conflicting reports in the literature concerning the destructive effect of water on microorganisms.[4] It is well known that the destructive power of water on bacterial cells depends on such factors as the initial concentration of organisms, the temperature and the hydrogen ion concentration. The majority of reports,[5] however, are in accord that pure water is not a desirable medium for bacterial existence.

In our study we tested the destructive effect of water by comparing the rate of survival of E. coli in distilled water, tap water, isotonic saline (made with distilled water), broth water (distilled water containing 0.1 per cent brain-heart infusion broth) and dechlorinized tap water. Table 4 is typical of the results of one of these experiments.

TABLE 4. — *The Effect of Water on the Growth of E. Coli.**

Time of Sampling	Number of E. Coli			
	In Distilled Water		In Saline	
	Pure	0.1% Broth	Pure	0.1% Broth
Immediate	136,000	220,000	220,000	250,000
After 20 minutes	72,000	146,000	145,000	160,000

* Initial number of E. coli 280,000 per milliliter according to titration.

These experiments showed that the number of E. coli surviving in pure distilled water was 40 per cent less than in broth water on immediate sampling and 50 per cent less after twenty minutes. The survival of E. coli in saline with or without broth was relatively the same, although the samples examined after twenty minutes showed 40 per cent fewer organisms than the immediate samples.

Staphylococci proved to be somewhat more resistant than E. coli to the destructive power of pure water.

Significance of Preliminary Experiments

Our preliminary test experiments indicated that a temperature of 44 C, chlorine and water each had a destructive effect on the micro-organisms studied. The period of exposure also was a factor, for considerably more bacteria were destroyed after twenty minutes than upon immediate sampling. A combination of these factors was found to destroy 95 per cent or more of the micro-organisms. Moreover, if traces of trisodium phosphate were present, the killing rate was even greater than when either of the factors was present alone.

Knowledge of the bactericidal effects of these factors usually encountered in hydrotherapeutic tanks made is possible to estimate the efficacy of ultraviolet rays in sterilization.

4. Topley and Wilson: Principles of Bacteriology & Immunity, Vol. I, 117:1946.
5. Ficker, Z.: Hyg. Infekt. 30:1, 1898. Winslow and Falk: J. Bact. 8:257, 1923. Houston, A. C.: Tenth Rs. Rep. Metrop. Water Bd., 1914.

Ultraviolet Ray Experiments in Hydrotherapeutic Tanks

On the basis of our preliminary experiments, we then set up a series of tests to determine the effect of ultraviolet rays (1) on the natural bacterial flora of tap water and (2) on test bacterial flora, including E. coli, Staph. aureus, enterococci, pseudoanthrax bacilli and T. mentagrophytes.

I. Effect of Ultraviolet Rays on Natural Bacterial Flora. — The tank was filled with water and thoroughly agitated. A 100 ml. control sample of water was taken. A second 100 ml. test sample was removed after twenty minutes of exposure to ultraviolet radiation.

For bacterial analysis, 1 ml., 10 ml. and 50 ml., specimens were tested both of the control and of ultraviolet-ray-exposed samples. The 10 ml. and 50 ml. specimens were centrifuged for twenty minutes at 3,000 revolutions per minute, and the sediment was resuspended in 1 ml. of water.

All the specimens were incorporated into blood agar plates within two hours, which was the usual length of time elapsing between the time the sample was taken from the hydrotherapeutic tank and brought to the laboratory.

Platings of the 10 and 50 ml. specimens taken before exposure to ultraviolet rays did not exceed 50 colonies in any of the tests. The 1 ml. samples usually revealed between 1 and 5 colonies.

The organisms found were Pseudomonas fluorescens, Staphylococcus albus, Staphylococcus citreus, Micrococcus tetragenus, pseudoanthrax bacilli and unidentified gram-positive bacilli.

Although prior to exposure to ultraviolet rays these micro-organisms were present in most of the experiments, after twenty minutes of exposure to irradiation no colonies developed.

It was noted that the number of bacteria recovered in these tank experiments was greater than in miniature tests with tap water collected from the faucet. This was attributed to the large surface of the tank.

The number of bacteria normally present in tap water was found to be too small to allow measuring the bactericidal power of ultraviolet rays. Therefore, in order to obtain statistically significant results, we seeded the tank with known bacterial cultures.

II. Effect of Ultraviolet Rays on Test Bacterial Flora. — The tank was inoculated with 0.01 to 0.1 ml. of eighteen-hour broth cultures of E. coli and Staph. aureus containing between 2,400,000,000 and 3,200,000,000 bacteria per milliliter.

It was calculated that these inoculums should have resulted in a bacterial suspension of 100 to 1,000 viable organisms per milliliter of water. However, the pour plates made from 1 ml. of undiluted water so inoculated repeatedly revealed only occasional colonies. The inoculum therefore was increased to 5, 10 and 20 ml. The results obtained are given in table 5.

Table 5. — *Effect of Ultraviolet Rays on E. Coli and Staphylococcus Aureus.*

Bacteria	Inoculum, ml.	Expected No. of Organisms per Ml. Tank Water*	No. of Organisms Recovered per Ml. Tank Water*	Per Cent Destruction of Ultraviolet Rays
E. coli	5	52,300	20	100
	10	104,400	130	100
	20	208,800	250	100
S. aureus	5	43,500	1,836	100
	10	87,000	4,116	100
	20	174,000	12,886	100

* According to titration.

It was evident from these experiments that although the ultraviolet rays destroyed the bacteria after twenty minutes of exposure, the number of recoverable organisms before exposure to irradiation was too small to permit a clear-cut picture of the destructive efficacy of the ultraviolet rays. In addition, the bacterial counts varied greatly in different experiments.

This prompted us to take the following precautions to eliminate the effect of such factors which our preliminary experiments had shown might influence the results:

1. Special efforts were made to remove traces of trisodium phosphate by repeated rinsings of the tank.

2. The tank water was dechlorinized by the addition of sodium thiosulfate or broth.

3. The bacterial inoculum was increased. Enterococci, pseudoanthrax bacilli and T. mentagrophytes were added to the E. coli and Staph. aureus. Eighteen hour broth culture of streptococci and two weeks old broth culture of pseudoanthrax bacilli containing numerous spores were used. T. mentagrophytes was cultured on corn meal agar for two weeks and used in the form of broth suspension. Smears of this suspension revealed numerous microspores and macroconidia. The usual inoculum was 50 ml. of broth culture.

In the first set of experiments 50 ml. of broth was added in addition to the 50 ml. of the test culture. Determinations of the chlorine content and *p*H were made prior to and after the addition of the broth and the test culture. Samples were were taken immediately after seeding, after twenty minutes of standing and after twenty minutes of exposure to ultraviolet rays. Table 6 summarizes the results of these experiments.

TABLE 6. — *The Effect of Ultraviolet Rays on Test Bacterial Cultures.*

Chlorine, PPM	*p*H	Bacteria	Growth of Bacteria			
			Expected No. per Ml.	Immediate Count	After Standing 20 Min.	After 20 Min. of Ultraviolet Rays
0.06	7.2	E. coli	650,000	587,500	378,300	0
0.06	7.2	Enterococci	650,000	590,000	400,000	0
0.08	7.4	Staph. aureus	520,000	478,000	257,000	0
0.08	7.6	Pseudoanthrax bacilli	8,670	6,800	3,600	0
0.07	7.4	T. mentagrophytes*	.....	.....	.....	.....

* Counting colonies of T. mentagrophytes was difficult. The appearance of growth in dilutions up to 1:1,000 indicated that the initial survival number ranged between 1,000 and 100,000 colonies per milliliter.

Under these conditions we finally succeeded in obtaining colony counts consistently large enough to allow a reliable estimate of the bactericidal effect of ultraviolet light. Table 6 indicates that the number of viable bacteria was diminished 30 to 50 per cent even after twenty minutes of standing in agitated water. This means that a certain percentage of the bacterial destruction was due to factors other than ultraviolet rays — temperature, water, agitation. This fact should be taken into consideration in estimating the bactericidal power of ultraviolet rays.

Nevertheless, it is significant that after twenty minutes of standing the number of micro-organisms still remained high, whereas the plates inoculated with irradiated water were uniformly free of bacterial and fungus growth.

This evidence of the destructive action of ultraviolet rays on bacteria prompted us to determine the extent of this destructive power. By using a total of 230 ml. of broth to create more favorable conditions for the growth of micro-organisms, we believed that it would be possible to increase the survival rate of the inoculated bacteria.

Subsequent tests with the increased broth concentration showed that 90 to 97 per cent of the bacteria in the inoculum were recovered. The excess broth, however, had the disadvantage that a large amount of foam revealed that some bacteria survived after exposure to ultraviolet radiation.

This finding indicated that the presence of excessive broth seems to interfere with the action of the ultraviolet rays on the bacterial cells. This observation is in accord with previous reports[15] that broth possesses a high coefficient of absorption of ultraviolet rays.

The interference of the broth with the efficacy of the ultraviolet radiation led us to dechlorinize the tap water with sodium thiosulfate. By removing the bactericidal action of the chlorine, we would then increase the viability of the bacteria. Table 7 indicates that not only a high bacterial survival was obtained in this way but that the ultraviolet rays destroyed all the surviving bacteria.

TABLE 7. — *The Effect of Ultraviolet Rays on Bacteria in Dechlorinized Water.*

Bacteria	Expected Number per Ml.	Immediate Count per Ml.	Count After 20 Min. Exposure to Ultraviolet Rays
E. coli	280,000	250,000	0
Enterococci	300,000	280,000	0

The success with dechlorinized water led us to use twenty-hour agar slant cultures of E. coli and enterococci suspended in isotonic saline solution in order to provide massive inoculums of the organisms. One extra large inoculum of E. coli provided an estimated 2,000,000 bacteria per milliliter of tank water. The actual count revealed 1,625,000 organisms per milliliter of water.

Table 8 shows that the survival rate of E. coli, seeded in massive numbers into dechlorinized water, ranged between 60 and 70 per cent. The results with enterococci were very similar, ranging between 65 and 78 per cent. In the presence of 0.2 parts of chlorine per million parts of tank water, only 5 to 10 per cent of the E. coli organisms could be recovered prior to exposure to ultraviolet rays. On the whole, the percentage of destruction was inversely proportional to the size of the initial inoculum: The heavier the inoculum, the smaller was the rate of the destruction.

TABLE 8. — *Effect of Ultraviolet Light on Massive Agar Culture Inoculum of E. Coli.*

Chlorine, PPM	Expected Number per Ml.	Immediate Count per Ml.	Count After 20 Min. Exposure to Ultraviolet Rays
0.2	300,000	35,000	0
Dechlorinized	300,000	220,000	0
Dechlorinized	2,000,000	1,625,000	0

Comment

The purpose of our study was to investigate the destructive power of ultraviolet radiation on various viable micro-organisms. This was most evident in experiments when a massive inoculum of 2,000,000 bacteria per milliliter of water was used.

Allowing for the fact that a small percentage of bacteria are destroyed by other factors, such as temperature, chlorine, and trisodium phosphate used for cleansing the tank, it is nevertheless significant that more than a million bacteria per milliliter of water were exposed to the ultraviolet rays and not

a single organism could be recovered after exposure for twenty minutes.

It is not likely that such a degree of contamination ever would be achieved in the hydrotherapeutic tank. No matter how extensive the infected lesion of the patient, the number of micro-organisms invading the tank would be considerably smaller than the inoculums used in our experiments.

Our results proved unequivocally that for practical purposes, ultraviolet radiation serves as a reliable sterilizing agent. For maximum effects, however, it is pointed out that simultaneous agitation of the water should be carried out. This is essential to enable every particle of the contaminated water to be exposed to the direct action of the rays, for it is well known that direct irradiation is more powerful than indirect irradiation.[11]

Summary

The possibility of using underwater ultraviolet radiation for the sterilization of water in hydrotherapeutic practice was investigated. To determine the destructive action of ultraviolet rays, various test micro-organisms were used, including E. coli, Staph. aureus, enterococci, pseudoanthrax bacilli and T. mentagrophytes.

Under conditions simulating hydrotherapeutic treatment, a considerable portion of the seeded organisms were destroyed prior to exposure to ultraviolet rays by the action of a temperature of 44 C, by chlorine (0.06 to 0.2 parts per million of tank water) and by the water itself.

In order to obtain a maximum survival of bacteria for an estimation of the true bactericidal power of ultraviolet rays, dechlorinization of water was accomplished by the addition of sodium thiosulfate or broth. Sodium thiosulfate appeared to be preferable to broth for this purpose, because of absorption of the ultraviolet rays by the broth allowed survival of some of the bacteria.

Various numbers of the micro-organisms, up to 2,000,000 per milliliter of water, were subjected to twenty minutes of exposure to ultraviolet rays with complete sterilization.

The underwater use of ultraviolet light can be recommended as a reliable sterilizing procedure in hydrotherapeutic practice. For optimum effects the water should be simultaneously agitated to permit exposure to the rays of every particle of contaminated water.

CLINICAL ELECTROMYOGRAPHY *

Physiologic Basis, Instrumentation, Diagnostic Value

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Clinical electromyography is the recording of electric activity in skeletal muscle for diagnostic purposes. In certain pathologic states the pattern of electric activity is pathognomonic, while in others it is a valuable diagnostic adjunct. Like electrocardiography and electroencephalography, it is based on the fact that nerve and muscle activity produces measurable electric potentials. In the heart and brain the electric pattern is complex. This is because the resultant of the activity of many parts of the organ is recorded. This is true of electromyography. However, with electromyography it is also possible to investigate the activity of the motor unit which is the basic physiologic element of skeletal muscle.

The Motor Unit

A motor unit is composed of one anterior horn cell, its axon and the muscle fibers which are innervated by it.[1] That one anterior horn cell innervates many muscle fibers is shown by the following facts:

1. A single axon keeps branching off into smaller fibers during its course in the peripheral nerve and in the muscle.[1]

2. The number of muscle fibers in a given muscle far exceeds the number of nerve fibers going to it. The number of muscle fibers supplied by a single axon varies from 30 to 300 in limb muscles.[2] The muscles of the face, tongue and larynx have smaller motor units.[3] A single muscle contains motor units of various sizes.[4] The muscle fibers of a motor unit contract simultaneously, since they receive the stimulus through the same nerve fiber. This contraction is accompanied with an electric potential which can be measured and recorded. The measuring and recording can be done with an electromyograph. The instrument is essentially an amplifier. Electrodes conduct the current from the muscle to the amplifier. The amplified current is then detected by some recording device.

Electrodes

The Coaxial Needle Electrode. — In order to enable one to record the potential difference produced by a single motor unit, or even a single muscle fiber, the coaxial needle electrode was devised.[4] It consists of an ordinary hypodermic needle into whose lumen an insulated wire is inserted. The needle forms one electrode, and the tip of

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‡ Fellow of the National Foundation for Infantile Paralysis.
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1. Eccles, J. C., and Sherrington, C. S.: Numbers and Contraction-Values of Individual Motor-Units Examined in Some Muscles of the Limb, Proc. Roy. Soc. London **106***B*:326, 1930.
2. Clark, D. A.: Muscle Counts of Motor Units: A Study in Innervation Ratios, Am. J. Physiol. **98**:286, 1931.
3. Weddell, G., Feinstein, B., and Pattle, R. E.: The Electrical Activity of Voluntary Muscle in Man Under Normal and Pathological Conditions, Brain **67**:178, 1944.
4. Adrian, E. D., and Bronk, D. W.: The Discharge of Impulses in Motor Nerve Fibers: II. The Frequency of Discharge in Reflex and Voluntary Contractions, J. Physiol. **67**:119, 1929.

the wire, which is flush with the bevel of the needle, the other. Because of their proximity both electrodes are within recording reach of the same motor unit.

Unipolar Needle Electrode. — A method which combines skin and needle electrodes is used by some. A simple needle electrode insulated except for its tip is inserted into the muscle. The other electrode is applied to the skin at the point of entry of the needle.[5]

Skin Electrodes. — In certain cases in which it is not necessary to investigate the motor unit and in which an additive recording of superficial portions of the muscle is satisfactory, skin electrodes may be used. Two small metal disks, 5 mm. in diameter, are applied to the skin over the muscle to be examined. To assure their firm application and constant spacing, they have been glued to a thin plastic plate. This plate is then pressed against the skin by adhesive tape. The skin resistance must be decreased below 5,000 ohms by cleansing the skin with acetone and rubbing it with electrode jelly before application of the electrodes.

A large skin electrode leading to the ground may be applied to the chest wall or near the recording electrodes. This is to eliminate the electrocardiogram from the tracing. Extraneous electric interferences are best eliminated by placing the patient within a copper screen cage.

Wires from the electrodes lead to an amplifier which increases the voltage of the current sufficiently to record it.

Recording Devices

Loud Speaker. — The simplest device to demonstrate the action current is the loud speaker.[3] A click indicates a short impulse; a thump, a longer one, and a rattling, a series of successive impulses. It is quite sensitive to minute potentials, yet, despite this, the range is large. The character of the sound gives an indication of the amplitude and duration of the potential. However, exact measurement of the potential by this means is not possible. The sound may be captured on records or magnetic tape for restudy.

Cathode Ray Oscillograph. — The most accurate recording instrument is the cathode ray oscillograph. A beam of electrons is placed between two parallel horizontal metal plates connected to the amplifier and is then detected by a fluorescent screen as a luminous spot. The potential difference created by the action current produces a vertical deflection of the spot. A special mechanism in the oscillograph, called the sweep, moves the spot horizontally with a variable speed which can be regulated. The tracing thus produced on the screen by the spot of light records the amplitude and duration of the potential.

This can be permanently recorded by a camera with open shutter and with constantly moving film. The movement of the film eliminates the necessity of the sweep.

Pen Writer. — Another recording device is a pen-writing mechanism. Sufficiently amplified action current will produce deflection of the pen, which then records on moving paper. The inertia of the pen does not permit the recording of very short impulses. This lack of sensitivity limits its usefulness.

The Action Potential

The contraction of a single muscle fiber is accompanied with a wave of negative electricity which travels along the fiber. Two electrodes placed in close proximity to each other will each receive the wave of negative electricity in rapid succession. This will produce a diphasic spike in the recording (fig. 1 *B*). Since all muscle fibers of a motor unit contract simultaneously and since they are close together in a conducting medium, a motor unit potential will also be a diphasic spike. Because of the additive effect of the many muscle fiber potentials, the amplitude of a motor unit potential is much greater than that of the muscle fiber. The duration is also greater.

This increase in duration may be due to a combination of several factors: First the individual muscle fiber potentials of a motor unit are slightly asynchronous, owing possibly to a difference in length of the axon branches. Second, since the fibers are at slightly different distances from the needle,

5. (*a*) Jasper, H. H.: Integration and Disintegration of Motor Units: Unipolar Electromyography in Neuromuscular Disease, Federation Proc. **6**:137, 1947. (*b*) Jasper, H., and Ballem, G.: Unipolar Electromyograms of Normal and Denervated Human Muscle, J. Neurophysiol. **12**:231, 1949.

their potentials take different times to reach the needle. Third, the farther the needle from the motor unit, the smaller will be the amplitude and the longer the duration of the potentials.[6] The diphasic spike is the basic pat-

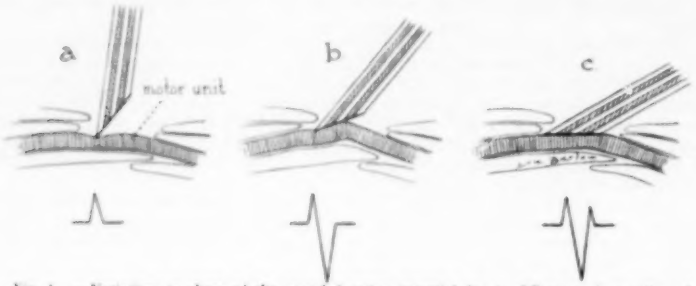

Fig. 1. — Variations in shape of the recorded action potential due to differences in position of the coaxial needle electrode.
A. Monophasic spike
B. Diphasic spike
C. Triphasic spike

tern of the electromyogram. The difference in amplitude and duration will determine whether it is being produced by a single muscle fiber or by a motor unit (fig. 2).

With the unipolar electrode, the basic pattern would be mostly a monophasic spike, the deviations in the opposite direction being of very low amplitude because of the great distance of the skin electrode from the motor unit.

Fig. 2. — Difference in amplitude and duration between muscle fiber and motor unit potentials.
X, X₁ Monophasic and diphasic muscle fiber potential
A. Diphasic motor unit potential

The Electromyogram

The electromyogram, in certain cases, may be completely or partially composed of identical diphasic potentials. However, modifications of this pattern occur in two ways. First, the shape of the individual motor unit potential may vary, and second, several motor unit potentials of different appearance may be recorded in the same tracing.

The shape of the motor unit potential may be monophasic or triphasic instead of diphasic. It depends on the position of the needle in relation to the muscle fiber.[6] The monophasic spike occurs when the needle barrel is in contact with the muscle fiber but the core electrode is pointed away from it. Thus the barrel electrode transmits most of the impulse resulting in a mono-

6. Denny-Brown, D., and Pennybacker, J. B.: Fibrillation and Fasciculation in Voluntary Muscle, Brain **61**:311, 1938.

phasic spike (fig. 1 *A*). This may be due to the fact that the needle electrode has directional properties.[4] When the needle is tilted so that besides the tip of the barrel the core is also in contact with the contracting fiber, the tip of the barrel and the core will each transmit at separate times the impulse, which now has two phases, each in a different direction. Finally, when the bevel is perfectly flat against the fiber, the wave of excitation will hit first the nearer side of the barrel, then the core and lastly the farther side of the barrel. The nearer and farther sides of the barrel, being part of the same electrode which is picking up the wave twice, will have phases in the same direction. In between these phases will be a third one in the opposite direction because the core is the other electrode (fig. 1 *C*). Other factors may influence the shape of the normal potential. In pathologic conditions a motor unit potential may be polyphasic.

Since the muscle is a volume conductor, the needle electrode may pick up potentials from neighboring motor units. It was found that potentials from motor units as far away as 1 cm. could be recorded if the bevel of the needle was turned toward them.[5] The recorded voltage decreases with increasing distance between needle and motor unit; hence a distant motor unit will be of low amplitude.[5b] At a given time each motor unit also has its own particular rhythm of contraction. The three characteristics of amplitude, shape and rhythm frequently allow one to recognize each

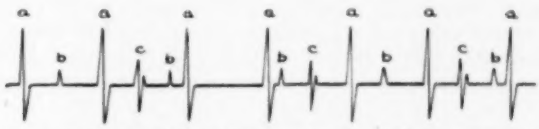

Fig. 3. — Tracing of slight voluntary motion. Three different motor units (a, b, c) are recorded, each of different amplitude, shape and rhythm.

individual motor unit in the tracing. In slight voluntary contraction three or four motor units may be picked up (fig. 3).

If many neighboring motor units contract, as would occur in medium and strong voluntary motion, there will be interference or overlapping. In this case, a tracing of irregular spikes with secondary indentations is seen, being the additive recording of many motor units (fig. 4 *A*). This interfering pattern makes impossible the analysis of individual motor unit activity.

For their interpretation it is useful to divide the electromyographic recordings into four main groups:

1. Muscle fiber potentials, or fibrillation.
2. Spontaneous motor unit potentials, or fasciculation.
3. Isolated motor unit potentials of voluntary motion.
4. Interfering potentials.

The first two groups are spontaneous and noninterfering patterns. The third group is a willed noninterfering pattern, while the fourth includes interfering patterns produced by either willed or spontaneous contraction.

Muscle Fiber Potentials (Fibrillation)

Muscle fiber, or fibrillation, potentials have certain unmistakable characteristics. The loud speaker reproduces them as a crepitating sound which is easily distinguished from the thump of the motor unit potential. On the cathode ray oscillograph they usually appear as small diphasic or monophasic spikes. They have an amplitude of about 50 to 100 microvolts, and the duration of each twitch is not more than 2 milliseconds (fig. 2). Because of their

short duration they are not recordable by pen-writing equipment, which has too much inertia. The twitches appear at a rate of 2 to 10 per second.[3] Fibrillation cannot be produced by volition and is therefore always spontaneous. Fibrillation potentials are increased in number by warming, passive motion, massaging of the muscle and parenteral injection of neostigmine.[3]

Fibrillation potentials are pathognomonic of muscular denervation, never being found in innervated muscle. They are produced by the haphazard contraction of muscle fibers. Their onset corresponds closely to the completion of wallerian degeneration, and they continue for many years until denervation atrophy of the muscle fibers has led to their transformation into fibrous tissue.

In peripheral nerve injuries, as early as four to five days after nerve section a few fibrillating areas may be detected by thorough probing with the needle electrode. In another ten days the whole muscle fibrillates. At that time the diagnosis of denervation can also be demonstrated by a reaction of degeneration. Regeneration of the nerve is indicated by a decrease in number of fibrillation potentials and by the appearance of motor unit potentials during attempted motion. This occurs long before traces of voluntary motion appear and also before the electrical reactions become normal. In this way electromyography may be of prognostic value.

Fibrillation is also found in poliomyelitis, peripheral neuritis and in the late stage of motor neuron disease. The relative number of fibrillation potentials and of motor unit potentials allows one to make an approximate evaluation of the degree of paralysis in any part of the muscle. Changes in this relationship would give an indication of prognosis. In this respect electromyography gives more information than galvanofaradic nerve-muscle testing.

Electromyographic recording of fibrillation is the only way to detect it clinically and therefore an important diagnostic measure in lower motor neuron lesions.

Spontaneous Motor Unit Potentials (Fasciculation)

The term fasciculation is used in electromyography to denote a spontaneous contraction of a motor unit. Fasciculation can be seen by the naked eye as a twitching when superficial motor units are involved. Some forms of clinical twitching, like those of myokymia, are not confined to the motor unit and should not be called fasciculation. Spontaneous motor unit potentials are of two types:

1. Sporadic discharges appearing at more or less regular intervals of ten seconds to two minutes (fig. 4*A*).
2. Fast rhythmic impulses at the rate of eight to ten per second (fig. 4*B*).

The latter have been subject to various interpretations, while the former are generally considered characteristic of motor neuron disease.

Slow Sporadic Fasciculation. — In motor neuron disease, a fasciculation consists clinically of a repeated brief twitch of an area 1 to 3 mm. wide and several centimeters long. It appears like a sudden tightening of a band depressing the skin. There may be a large number of twitching areas, but each motor unit fasciculates at intervals of ten seconds to two minutes.

In the electromyograph each twitch appears as a single spike of five to ten milliseconds duration and with an amplitude of 100 to 500 microvolts (fig. 4*A*). In motor neuron disease the fasciculating motor unit is capable of voluntary contraction and its spontaneous discharge is not abolished by contraction of the antagonist.[4]

The origin of fasciculation in motor neuron disease was believed to be in the anterior horn cell, since this is the part affected.[6] However, experiments with procaine infiltration of the motor nerve and with complete nerve section seem to contradict this theory. Fasciculation persists for four to five days after nerve section, that is, until wallerian degeneration has set in. Therefore the origin of these fasciculations must be in the peripheral portion of the nerve fiber, in the myoneural junction or in the muscle.[7] It is believed that they may originate anywhere within the lower motor neuron.[8] If they originate in the myoneural junction or in a muscle fiber, the synchronous contraction of all the muscle fibers or a motor unit is explained by axon reflex.[7b]

These slow fasciculations have been described in motor neuron disease because the clinical picture is very conspicuous. So many motor units are frequently involved that, despite the slow repetition of each individual motor

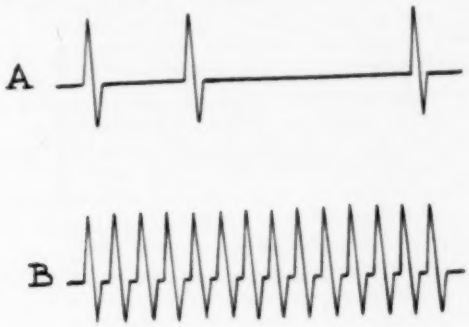

Fig. 4.
A. Slow sporadic fasciculation
B. Fast rhythmic fasciculation

unit, the muscle is animated by continuous twitching. Fasciculations of this type, however, may be seen clinically and electromyographically in other types of lower motor neuron involvement, though in smaller number. Even in normal subject one or two isolated fasciculations may occasionally be seen on the electromyogram when needle electrodes are used. They are probably due to the mechanical stimulation of nerve or muscle by the needle. After intramuscular injection of large doses of neostigmine intense fasciculation may appear in certain muscles.

The fasciculation of motor neuron disease should be distinguished from two other forms of clinical twitching:

1. Twitchings which occur in slightly tense muscle in neurogenic atrophy. They always disappear with complete relaxation and also with contraction of the antagonist. Electromyographically, they are fast rhythmic fasciculations and of high amplitude. They appear clinically as isolated twitching areas because the surrounding motor units art atrophied.
2. Tetanic twitchings which are seen in myokymia and cramplike states. They are slow undulating contractions. In the electromyogram they are represented by a tetanic high frequency discharge as in a brief strong voluntary contraction.

7. (a) Forster, F. M., and Alpers, B. J.: The Site of Origin of Fasciculations in Voluntary Muscle, Arch. Neurol. & Psychiat. 51:264, 1944. (b) Forster, F. M.; Borkowski, W. J., and Alpers, B. J.: Effects of Denervation on Fasciculation in Human Muscle: Relation of Fibrillations to Fasciculations, ibid. 56:276, 1946. (c) Swank, R. L., and Price, J. C.: Fascicular Muscle Twitchings in Amyotrophic Lateral Sclerosis: Their Origin, ibid. 49:23, 1943.

8. Hoefer, P. F. A.: Electromyographic Study of the Motor System in Man, Monatsschr. f. Psychol u. Neurol. 117:241, 1949.

Fast Rhythmic Fasciculation (fig. 4 *B*). — The interpretation of fast rhythmic motor unit potentials requires a good deal of clinical judgment, since they may be caused by many factors. They always signify slight muscular contraction, whether voluntary or involuntary. Only the latter may be called fasciculation. Involuntary muscular contraction may be psychogenic, generally called tenseness, or reflex, due to painful, postural or other stimuli. When this contraction is strong enough to be palpable or to limit the range of motion, it is the phenomenon known clinically as muscle spasm. In this case the fasciculation is replaced by an interfering pattern.

A completely relaxed muscle shows no electric activity. However, there is no clinical way to recognize a slight degree of muscular contraction. Even under normal conditions, some muscles, like those of the face, are very difficult to relax completely, while others, like those of the neck, are nearly impossible to relax. Nevertheless, when recording fast fasciculations, one should be sure that the patient is relaxed as much as possible. He should be positioned in such way as to eliminate gravity and thus postural reflexes. Pain reflexes due to insertion of needle electrodes may be avoided by injecting a few minims of procaine into the skin.

Fast spontaneous motor unit potentials were described in poliomyelitis and in Guillain-Barré syndrome. These potentials appear in the paretic muscles. Their existence was explained as caused by direct irritation of the motor nerve during the acute phase of the disease.[9] It is more likely, however, that they are due to postural tension in a weak muscle or to pain reflex. Other workers found no fasciculation in these conditions.[10]

Similar potentials were also found in spinal nerve root compression by a herniated nucleus pulposus or by spinal cord tumors. The level of this compression can be localized by examining muscles innervated by different segments.[11] Fasciculation is found only in muscles innervated by compressed segments while other muscles are electrically silent. The muscles of the upper extremities may be used in lesions of the cervical portion of the spine, the paravertebral muscles in lesions of the thoracic portion of the spine and the lower extremities in lesions of the lumbar portion of the spine.

These fast fasciculation potentials may be considered as a mild form of muscle spasm. They gain diagnostic value only if comparison with other muscle groups is made and if all possible reflexogenic factors are carefully evaluated.

Isolated Motor Unit Potentials of Voluntary Motion

Simple Motor Unit Potentials. — Isolated motor unit potentials are seen normally in very slight voluntary motion.[12] On strong or medium effort, however, an interfering pattern is produced in normal muscle and also in atrophic muscle when the atrophy is due to disuse or to muscular dystrophy.

This is not the case in partial denervation, in which isolated motor unit potentials are seen during strong voluntary effort. This is because only a

9. (a) Brazier, M. A. B.; Watkins, A. L., and Schwab, R. S.: Electromyographic Studies in Muscle Dysfunction in Infectious Polyneuritis and in Poliomyelitis, New England J. Med. **230**:185, 1944. (b) Watkins, A. L.; Brazier, M. A. B., and Schwab, R. S.: Concepts of Muscle Dysfunction in Poliomyelitis Based on Electromyographic Studies, J. A. M. A. **125**:185, 1945.

10. Buchthal, F., and Clemmesen, S.: On the Differentiations of Palpable Muscles Affections by Electromyography, Acta med. scandinav. **105**:8, 1940. Buchthal, F., and Honcke, P.: Electromyographical Examination of Patient Suffering from Poliomyelitis, Followed Up to Six Months After the Acute Stage of the Disease, Acta med. scandinav. **116**:719, 1944. Watkins, Brazier and Schwab.9b.

11. Brazier, M. A. B.; Watkins, A. L., and Michelsen, J. J.: Electromyography in Differential Diagnosis of Ruptured Cervical Disk, Arch. Neurol. Psychiat. **56**:651, 1946. Hoefer, P. A., and Guttman, S. A.: Electromyography as a Method for Determination of Level of Lesions in the Spinal Cord, ibid. **51**:415, 1944.

12. Hoefer, P. A., and Putnam, T. J.: Action Potentials in Muscles of Normal Subjects, Arch. Neurol. & Psychiat. **42**:201, 1939.

few motor units are within reach of the recording ability of the needle. Most of the neighboring muscle tissue has been denervated and therefore cannot produce potentials which interfere. Differential diagnosis between myogenic and neurogenic muscle atrophy depends on this fact (fig. 5).[13]

Complex Motor Unit Potentials (Re-innervation Potentials). — Complex motor unit discharges on attempts of voluntary motion are seen during the recovery phase of the lower motor neuron lesions. They are polyphasic and of medium or low voltage and appear at a rate of 2 to 20 per second (fig. 6).[14] The polyphasic character of these reinnervation potentials may

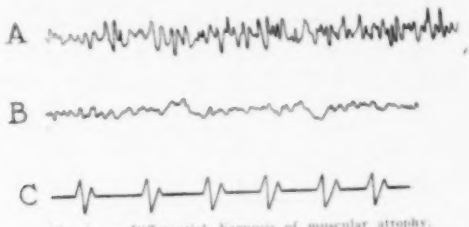

Fig. 5. — Differential diagnosis of muscular atrophy.
A. Normal muscle: High amplitude interfering pattern
B. Myogenic atrophy: Low amplitude interfering pattern
C. Neurogenic atrophy: Non-interfering pattern.
These tracings are obtained during maximum voluntary effort.

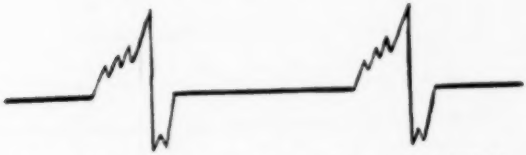

Fig. 6. — Complex motor unit potentials. (Reinnervation potentials).

be explained by the fact that the contractions of the recently reinnervated muscle fibers of a motor unit are not quite synchronous as yet. These complex potentials may represent a transition state from single muscle fiber potentials to motor unit potentials. Their existence may be a sign of good prognosis. They are quite frequent in the early stages of recovery but may also be seen occasionally as late as eighteen months after onset of paralysis. They cannot be sustained by voluntary effort for any length of time.[8]

Synchronized Motor Unit Potentials. — Besides being able to distinguish between myogenic and neurogenic atrophy, one can also differentiate between various types of neurogenic atrophy. When the anterior horn cell is involved, as in poliomyelitis, motor unit potentials from all parts of the involved muscle occur synchronously (fig. 7 *A*).[15] In peripheral neuritis, where the anterior horn cells are intact, motor unit potentials from various parts of the muscle are asynchronous (fig. 7 *B*).[16] It would appear that even normally a certain number of motor units must contract nearly synchronously in order to furnish the instantaneous power while the out of phase motor units act as replacements, thus delaying fatigue and smoothing out the motion. If only a few anterior horn cells are functioning, as occurs in anterior horn cell dis-

13. Buchthal, F., and Clemmesen, S.: On the Differentiation of Muscle Atrophy by Electromyography, Acta psychiat. et neurol. **16**:143, 1941.
14. Golseth, J. G., and Huddleston, O. L.: Electromyographic Diagnosis of Lower Motor Neuron Disease, Arch. Phys. Med. **30**:495, 1949.
15. Buchthal, F., and Clemmesen, S.: The Electromyogram of Atrophic Muscles in Cases of Intramedullary Affections, Acta psychiat. et neurol. **18**:377, 1943.
16. Buchthal, and Clemmesen.15. Watkins, Brazier and Schwab. 9b.

case, it seems logical to assume that the bulk of the available cells will act synchronously in order to approach maximal power. In this case the properties of smoothness and endurance are sacrificed for the sake of power. This regulatory mechanism does not exist when the central nervous system is intact.

The technic involves simultaneous recording from at least three needle electrodes inserted into different areas of the same muscle.

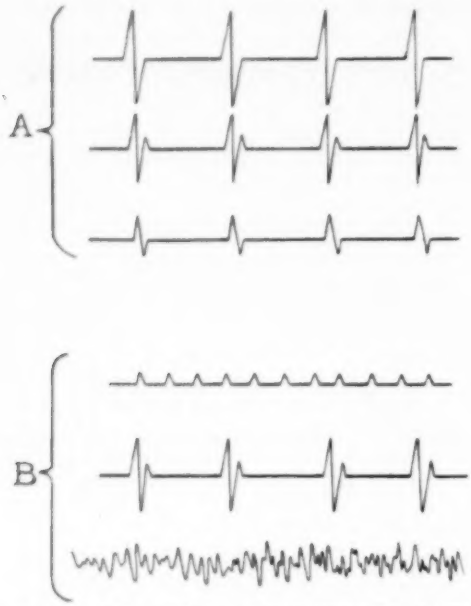

Fig. 7. — Differential diagnosis between anterior horn cell and peripheral nerve involvement.
A. Synchronous discharges in three leads from the same muscle
B. Asynchronous discharges in three leads from same muscle

Interfering Potentials

Isolated potentials are of diagnostic value only when the lower motor neuron is involved. Thus in central nervous system disease with intact lower motor neuron the interpretation of interfering potentials becomes important. Since single recordings of interfering potentials are not characteristic and since the central nervous system controls coordinated functioning of muscles, simultaneous multichannel recording from various areas of one muscle, and from several muscles, is a necessary technic for the interpretation of most interfering potentials.

Interfering potentials are seen in strong voluntary motion in the normal person. They are also present in persons with involuntary motions such as chorea, dystonia, athetosis and tremor. In such cases the electromyogram is usually not very characteristic. In fact, the electromyograms of the various involuntary motions show much more similarity than the clinical picture.[12] This may be indicative of a similar localization of the lesions producing these movements.

Diagnostically important abnormalities of the interfering potential may be classified into three groups: (*a*) spontaneous interfering potentials, (*b*) mass interfering potentials and (*c*) rhythmic interfering potentials.

Spontaneous Interfering Potentials. — Spontaneous interfering potentials occur without visible movement and during as complete relaxation of the patient as is obtainable. They are seen in muscle spasm and in rigidity.

Muscle spasm, if strong enough, has an interfering pattern. The tracing is entirely indistinguishable from that of a willed contraction. It may be localized to one or several muscles. Very slight spasm appears as fasciculation and was described previously as fast rhythmic motor unit potentials in poliomyelitis, Guillain-Barré syndrome and spinal cord compression. The interfering pattern may also occur in these disorders, as well as in painful orthopedic conditions. In some cases of palpable muscle spasm no electric activity is found.[17]

Rigidity is characteristic of basal ganglion disease. It consists of simultaneous continuous contraction of all muscles of the affected limbs, thus opposing active and passive motion and maintaining the limb in a fixed posi-

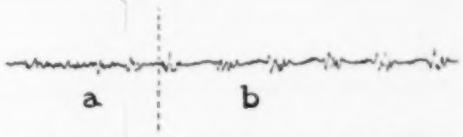

Fig. 8. — Transition from rigidity to tremor in Parkinsonism.
(a) Low amplitude interfering pattern of rigidity.
(b) Rhythmic bursts of interfering potentials occurring in tremor.

tion. This continuous muscular contraction causes the interfering action potential. Its amplitude is low, but it is present at all times in all affected muscles (fig. 8 *a*). In cases of tremor, the rigidity potentials disappear between bursts of tremor, as will be seen later. The resting activity aids in distinguishing rigidity from spasticity, since the relaxed spastic muscle shows electric silence.[18]

Mass Interfering Potentials. — By this term it is meant that nearly all motor units contract simultaneously and strongly within the same muscle as well as in other muscles of the same limb, including antagonists. This synchronous mass activity may be produced by an attempt of voluntary motion or reflexly. It is the electromyographic expression of the clinical pictures of spasticity and rigidity. It is also seen in painful disorders in which the contraction of antagonists protects against painful movement. From the diagnostic standpoint, electromyography adds nothing to the clinical picture. The simultaneous strong widespread muscular contractions in spasticity and rigidity explain the lack of finer motion and the easy fatigability.

Rhythmic Interfering Potentials. — Although a rhythmic pattern may be found in involuntary movements, only the pattern found in parkinsonism is pathognomonic.

Parkinsonian tremor consists of short bursts of interfering action potentials separated by intervals of electric silence. Burst and interval are about of equal length. The rate varies from 3 to 5 bursts per second (fig. 8 *b*).[19]

17. Hoefer, P. A., and Putnam, T. J.: Action Potentials of Muscles in Athetosis and Sydenham's Chorea, Arch. Neurol. Psychiat. **41**:517, 1941. Hoefer.[a]
18. Hoefer, P. A., and Putnam, T. J.: Action Potentials in Muscles in "Spastic Conditions," Arch. Neurol. Psychiat. **43**:1, 1940.
19. Ingebrigtsen, B.: Practical Application of Electromyography in the Diagnosis of Tremor, Acta psychiat. et neurol. **13**:11, 1938.

An interesting feature is the identical rhythm of these bursts in all parts of the same muscle and all involved muscles of the body. However, bursts alternate in opposing muscles. This indicates a possible coordinating central mechanism.[20]

This pattern of parkinsonian tremor may be found before tremor is clinically noticeable. It is present in some muscles while others show only rigidity potentials. Sometimes the rhythmic pattern is produced during voluntary or passive motion. Thus electromyography helps with the early detection of Parkinson's Disease.

Special Diagnostic Technics

Certain aspects of electromyography which are still in the laboratory stage may soon become clinical tools.

The importance of electromyography in the study of kinesiology was recognized long ago, but little work has been done on this subject.[21] The recording of action potentials gives a sure indication which muscles a disabled

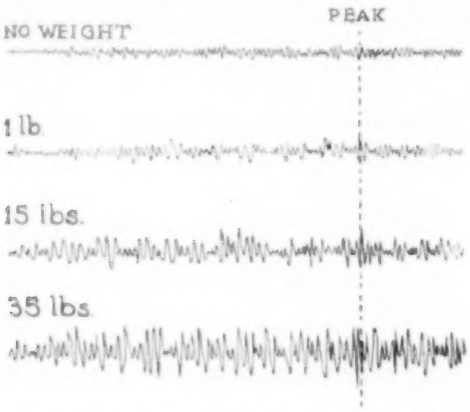

Fig. 9. — Increase of amplitude of the interfering pattern recorded from the Rectus Femoris during knee extension with increasing loads. Peak indicates pattern at full extension.

patient uses or does not use in certain activities. Such knowledge may be useful for the prescription of corrective exercises and for adequate bracing.

Another aspect to be further investigated is the relation between muscular effort and amplitude of the interfering potential recorded by skin electrodes. There exists a definite relationship (fig. 9). The amplitude of the potential produced by muscle action against maximal resistance may show improvement or further impairment of muscle strength.

A more objective manner of assessing the number of functioning motor units in a partially denervated muscle consists in electrical stimulation of the motor nerve with supramaximal stimuli. A single diphasic spike is thus obtained, the amplitude of which is determined by the sum of all motor unit potentials in the vicinity of the electrode. This test is of value only in small muscles in which most fibers are within recording reach. Comparison with the same muscle on the opposite side is necessary.

20. Hoefer, P. A., and Putnam, T. J.: Action Potentials of Muscles in Rigidity and Tremor, Arch. Neurol. & Psychiat. **43**:1043, 1940.

21. Bierman, W., and Yamshon, L. J.: Electromyography in Kinesiologic Evaluations, Arch. Phys. Med. **29**:4:208 (April) 1948. Wachsmuth, K.: Willkürliche Haltung und Bewegung, Ergbn. d. Physiol. **26**:1168, 1928.

By use of repetitive stimuli at short intervals, fatigability may be determined. Fatigue is shown by a gradual decrease in amplitude of the action potential. Generally the ulnar nerve and the muscles of the hypothenar eminence are used.

Conclusions

1. Clinical electromyography is of definite diagnostic value in lower motor neuron lesions, in muscular atrophies due to various causes, in localization of spinal cord compression and in Parkinson's disease.
2. Clinical electromyography is of definite prognostic value in lower motor neuron lesions.
3. Clinical electromyography has contributed to the knowledge of the organization of normal voluntary motion and the disorganization of motion occurring in nervous system diseases.
4. Clinical electromyography is able to contribute to further knowledge in problems of kinesiology, endurance and power.

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THE PREVENTION OF ULTRAVIOLET ERYTHEMA BY TOPICAL APPLICATION OF PYRIBENZAMINE *

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In a previous report we indicated that Pyribenzamine (N-pyridyl-N-benzyl-N-dimethylethylenediamine hydrochloride) is an effective agent when applied locally to prevent the erythema caused by ultraviolet radiation.[1] In the study presented here we endeavored to investigate the mode of action of this drug.

Method

All our subjects were white adults. They were exposed to a mercury vapor quartz lamp. A photoelectric barrier layer cell (Weston Photronic) with a Woods' filter was used to standardize the lamp for each experiment.

Pyribenzamine hydrochloride was dissolved in propylene glycol and aerosol O. T. (DuPont). Ten per cent and 5 per cent solutions were applied directly to the skin. The aerosol was added to aid the spreading quality of the lotion and to facilitate penetration into the deeper layers of the skin.

To evaluate the effect of physical screening, the solution was placed between two thin quartz slides. In every experiment we used the bare uncovered skin and the solvent

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* From the Department of Physical Medicine, The Mount Sinai Hospital.
* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 9, 1949.

1. Kurtin, A.; Bierman, W., and Yontef, R.: The Inhibition of Erythema Solare in the Normal Subject with Pyribenzamine, J. Investigative Dermat. 9:163, 1947.

without medication as controls. As a secondary control three substances with an absorption curve similar to pyribenzamine but without any antihistaminic activity were used (paraaminobenzoic acid 2-benzyl-aminopyridine and 2-benzoyl-amino pyridine). All these chemicals were applied in 10 per cent concentration.

In addition, 10 per cent solution of Benadryl was used as a substance with a known antihistaminic activity but with an absorption spectrum which transmits ultraviolet radiation.

Results

We estimated the erythema by a scale ranging from 0 to 4 (0, none; 1, minimal erythema dose; 2, mild erythema; 3, marked; 4, severe). A more or less typical response is that indicated in table 1. In the last two examinations indicated on this chart reference is made to the presence or absence of pigmentation. The visual interpretations were compared with readings from a reflectometer in an effort to obtain more exact objective criteria. This instrument measures the amount of reflected light. It was used with several color filters, but readings made with it did not prove accurate. We also

Summary of Observations.

Time of Exposure in Minutes	10	9	8	7	6	5	4	3	2	1	
10% solution	2	2	2	2	2	2	1	1	0	0	24 hours
5% solution	3	3	3	3	3	3	2	2	1	0	after
Solvent solution	3	3	3	3	3	3	3	3	2	1	exposure
Uncovered area	3	3	3	3	3	3	3	2	1	0	
10% solution	2	2	2	2	2	2	1	0	0	0	2 days
5% solution	3	3	3	2	2	2	2	1	0	0	after
Solvent solution	4	4	4	4	4	4	3	3	2	1	exposure
Uncovered area	4	4	4	4	4	4	3	2	2	1	
10% solution	1	1	1	1	1	1	0	0	0	0	3 days
5% solution	3	3	2	2	2	2	1	0	0	0	after
Solvent solution	4	4	4	4	3	3	3	2	1	0	exposure
Uncovered area	4	4	4	4	3	2	2	2	1	0	
10% solution	1	1	1	1	1	1	0	0	0	0	4 days
5% solution	2	2	2	2	2	2	1	0	0	0	after
Solvent solution	3	3	3	3	2	2	2	1	1	0	exposure
Uncovered area	3	3	3	3	3	2	2	1	1	0	
10% solution	VFP	VFP	VFP	VFP	VFP						7 days
5% solution	FP	FP	FP	FP	FP	FP					after
Solvent solution	P	P	P	P	P	P	FP	FP			exposure
Uncovered area	P	P	P	P	P	FP	FP	FP			
10% solution	VFP	VFP	VFP	VFP	VFP						14 days
5% solution	FP	FP	FP	FP	FP	FP					after
Solvent solution	P	P	P	P	P	P	FP	FP			exposure
Uncovered area	P	P	P	P	P	FP	FP	FP			

P — Pigmentation
FP — Faint pigmentation
VFP — Very faint pigmentation

employed a device utilizing a photoelectric cell to measure fluorescence. Patients were given fluorescein intravenously. The erythematous areas showed less fluorescence than the surrounding normal skin. A third method which also proved unsatisfactory was the use of a "densimeter." We measured the density of erythemal spots on Kodachromes with the help of different-colored filters. After all these attempts, we concluded that the unaided human eye was still the most accurate instrument for our purpose (fig. 1).

Five of the subjects were exposed to ultraviolet radiation for periods varying from one to ten minutes. The minimal erythema dose was below one minute.

There is close similarity between the curve showing the absorption spectrum of pyribenzamine and of that portion of the ultraviolet spectrum producing the maximum erythema (fig. 2). The preponderance of energy radiation from the mercury vapor in a quartz burner which we employed in these tests is at a wavelength of 2,537 Å. However, solar ultraviolet radiation begins only at about 2,900 Å. The superimposition of the erythema wavelength and sunlight energy wavelength curves points to peak distribution at

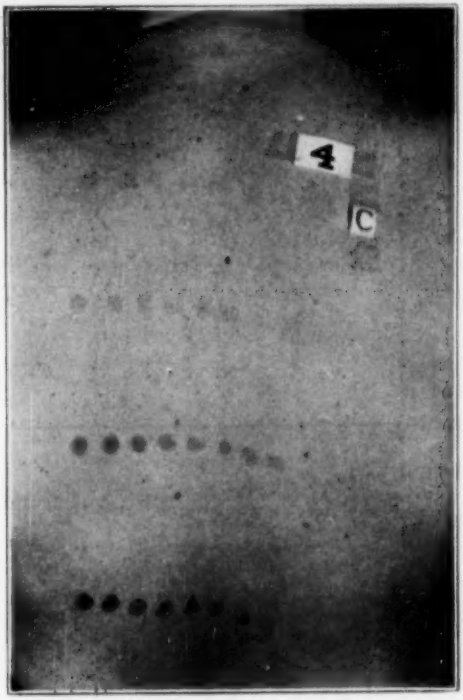

Fig. 1. — Appearance of reaction four days after exposure to ultraviolet radiation: top row, 10 per cent Pyribenzamine; second row, 5 per cent Pyribenzamine; third row, solvent solution; bottom row, control solution.

3,080 Å[2] (fig. 3). The peak of absorption of Pyribenzamine occurs at this wavelength. Solution of Pyribenzamine sandwiched between two thin quartz slides was interposed between the skin and the ultraviolet radiation source. The effective filtration of ultraviolet rays is shown in figure 1.

We applied 10 per cent solution of Pyribenzamine to patients immediately after exposure to ultraviolet radiation in the effort to determine whether Pyribenzamine acts as a pure physical filter or whether it has some additional pharmacologic effect. In 5 of our subjects there was no discernible difference between the control and the treated area. One subject, however, showed a definite decrease of erythema. Skin areas which were exposed to

2. Coblentz, W. W., and Stair, R.: J. Research, National Bureau of Standards **12**:13, 1934. Kumler, W. D., and Daniels, T. C.: Sunscreen Compounds, J. Am. Pharmacols. **37**:11, 1948.

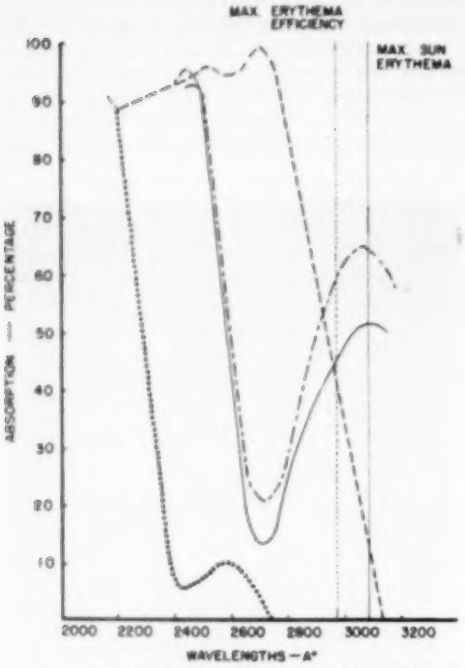

Fig. 2. — Spectral absorption curves of Benadryl (dotted line), Pyribenzamine (solid line), 2-benzoyl aminopyridine (dots and dashes) and 2-benzyl aminopyridine (dashes).

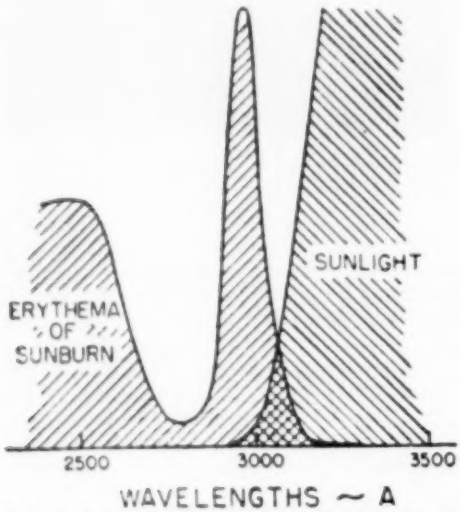

Fig. 3. — Erythema wavelength and sunlight energy wavelength curves (from Coblentz and Stair[7]).

ultraviolet radiation after previous application of 10 per cent Benadryl solution did not show any less erythema than the control areas.

When we first reported that topical application of Pyribenzamine in solution protects the skin against ultraviolet radiation, we considered that this influence was due to a possible antihistaminic action of the drug.[1] Shortly thereafter we noted that the action was due essentially to the ability of Pyribenzamine to absorb radiation in the ultraviolet range. Baer and his coworkers have since reported this fact in their discussion on the "Nature of Inhibition of Ultraviolet Erythema by Pyribenzamine."[2]

Friedlander and associates studied the spectral absorption of antihistaminic drugs and found that the greatest absorption within that portion of the spectrum responsible for sunburn occurred when Pyribenzamine was used.[4] The other antihistaminic drugs in the order of their decreasing effectiveness were Thenylene, Neoantergan, Pyrollazote, Tagathen, Neohetramine and Antistine.

Conclusions

Pyribenzamine is an effective agent in the prevention of the erythema produced by ultraviolet radiation. A ten per cent solution of Pyribenzamine affords complete protection against an exposure equal to 3 minimal erythemal doses and protects well, with only mild erythema formation, against 10 minimal erythemal doses.

We were unable to demonstrate any special chemical or biologic action to account for this protective influence. This effect seems to be produced by a purely physical barrier to ultraviolet radiation.

Discussion

Dr. S. G. Gamble (Cleveland): The paper just presented represents two phases of research that undoubtedly will be investigated more and more in the next few years, ultraviolet radiation and the application of antihistamine drugs in various forms.

All of us here are well aware of the scarcity of well controlled studies on ultraviolet rays. In the past as now, clinical empiricism is the main indication for use. The specific mode of action, as to its chemical effect, is still not known. When the fundamental physiologic principles are known, a greater number of specific indications for this powerful physical agent will develop.

Antihistamine drugs are, of course, riding the wave of popularity at this time, having been prescribed for almost every condition. As in all studies of any value, careful controls are necessary. This has well been emphasized by the authors, in that in their preliminary report it was considered that the protection of the skin against ultraviolet radiation was due to a possible antihistamine action of the drug. Their present work with proper controls gives the final answer as a purely physical barrier. They are to be commended on their scientific approach and professional honesty. It is hoped that they will continue their studies with similar application to sunlight, for, as they have stated, the preponderance of energy radiated from the mercury vapor quartz burner used in this experiment was at a wavelength of 2,537 Å while solar ultraviolet radiation begins around 2,900 Å.

This naturally leads to the problem of sensitivity to light, about which much scientific investigation is being performed at the present time. Many here may not have been especially interested in papers presented in previous years, primarily by dermatologists and their associates; hence a brief review, I think, might be worth while.

Very briefly, conditions in which photosensitivity is not acquired through an artificially introduced agent may be classified as idiopathic. There are two general types: (1) those that represent abnormal response to the radiation which causes erythema of normal skin — that is, those wavelengths which cause erythema of sunburn and are shorter than 3,200Å; (2) those in which the skin is affected by wavelengths to which normal skin is insensitive — that is, over 3,200 Å. These wavelengths go through window glass.

This classification is convenient as to two different types of etiology. It also makes possible differentiation to a certain

3. Kline, P. R., and Baer, R. L.: Nature of Inhibition of Ultraviolet Erythema by Pyribenzamine: Preliminary Report, J. Investigative Dermat. **10**:397, 1948. Baer, R. L.; Kline, P. R., and Rubin, L.: Nature of Inhibition of Ultraviolet Erythema by Pyribenzamine, ibid. **11**:6, 1948.

4. Friedlaender, A. S.; Friedlaender, S., and Vandenbelt, J. M.: Spectral Absorption Studies of Antihistaminic Drugs: Preliminary and Short Reports, J. Investigative Dermat. **11**:6, 1948.

degree by filtering through window glass.

Therefore we have polymorphic light eruptions, caused by wavelengths shorter than 3,200 Å and urticaria solaris caused by wavelengths above 3,200 Å and mainly between 4,000 and 5,000 Å. In the latter group two types have definitely been established, those due to wavelengths under 3,700 Å and those due to wavelengths between 4,000 and 5,000 Å. Other types, no doubt, exist.

The sensitivity of skin is generally high from wavelengths of 3,130 to 3,650 Å but virtually zero to any beyond this — that is, wavelengths greater than 3,700 Å. As stated, common window glass cuts off virtually all the wavelengths that affect normal skin.

Skipping along to the action of the antihistamine drugs: Lewis postulated in 1927 that allergic reactions were dependent on or were produced by the liberation of a histamine-like substance, called H substance, at the site of the reaction. Most investigators now are of the opinion that histamine and the H substance are identical or nearly so.

In 1933, Fourneau and Bovet first demonstrated that certain phenolic ethers counteracted the action of histamine in vitro and in vivo. Many compounds have since been synthesized but most discarded because of their toxicity. It is generally believed that the antihistamine drugs exert their therapeutic influence by competing with histamine for various sites of action on the cell.

A number of investigators have shown inhibition of histamine wheal by these drugs when they are administered orally, by injection or by ion transfer. One group has reported the prevention of erythema solare in a sensitized person by oral administration.

In the final analysis, the authors' presentation today is an approach to a number of overlapping clinical problems. Common ones are the treatment or prevention of sunburn and the prostration following sunburn, as the authors have mentioned in their preliminary report. Another might be with regard to their use as a prophylactic agent in relation to the activation or dissemination of discord lupus erythematosis, which we all know occurs at times when there is an overexposure to ultraviolet.

Needless to say, we should all be interested in future developments along these lines.

TRANSFER OF RESPIRATOR PATIENTS *

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During the 1948 poliomyelitis epidemic at the Los Angeles County Hospital, it became necessary to move respirator patients to other hospitals 15 to 20 miles distant.

Selection of Patients

Selection of respirator patients to be moved was made by the consulting physiatrist (C.W.D) in consultation with the chief medical resident. The following considerations were most important: 1. The patient must have been afebrile for at least one week and without complications such as atelectasis, gastric distention or pulmonary edema, 2. Open tracheostomies, Levin tubes and oxygen administration did not contraindicate movement of the patient, 3. With proper facilities, patients could be moved who could be out of the respirator only one minute or less.

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Equipment

Success in moving respirator patients resulted only from comprehensive attention to detail so that the patient had every hospital facility present during the time of actual transfer. It was also important to prevent the possibility of mechanical failure, and alternate methods of carrying out all medical procedures were always available.

The truck used had a bed long enough to permit the respirator to be opened in transit. It was wide enough that in case of failure of the power supply the respirator could be hand operated. Thus, a truck having a bed 10 or 12 feet long and 6 or 7 feet wide was required. The covered top was high enough to permit the doctor and nurse attending the patient to stand while working. The back end of the truck was left open for ventilation and to enable observers following in an ambulance to watch the patient and his attendants.

A portable gasoline generator supplied electrical energy for operation of the respirator and suction apparatus. Our truck was equipped with a Briggs-Stratton motor connected with a 1,500 watt generator having necessary convenience outlets so that suction apparatus and other necessary equipment could be plugged in. This generator allowed simultaneous operations of two respirators, two suction machines and necessary lights for four hours without interruption. The generator exhaust was run to the bottom of the truck or to the roof to keep the patient's section free of fumes.

The respirator was fastened to the truck in order that there would be no shifting, but the respirator carriage, of course, was left free so that it could be pulled out far enough to remove the patient rapidly in case of an emergency. Adequate room was left for hand operation of the respirator, and a special short bar was designed for this procedure. Specially designed rubber shock absorbers were placed under the legs of the respirator to minimize vertical jolting and vibration.

Recommendations for moving the patient were entered on the chart at least forty-eight hours before the contemplated date of transfer, including special instructions for transfer, such as the need of oxygen, suction and maintenance of adequate respirator pressure. The facilities needed at the secondary hospital were clarified and were checked with those available. At this point tentative orders for transfer were transmitted to the chief resident physician, the nursing office, the registrar, the ward nurse, the medical social worker, the physical medicine department and the receiving hospital. On the day of transfer the chief resident physician gave final release and assigned a physician and nurse to accompany the patient in the truck.

An adequate time before discharge the patient was given routine care. A special effort was made to prepare him psychologically, but if there was any appreciable resistance to the move the trip was canceled. It was found that any physical exertion that could be postponed for a day or two should be suspended.

Patients were steadied with silence cloth tied around the knees and under the respirator carriage and a broad abdominal binder was fastened in the same way to prevent undue shaking of the abdomen, yet permitting adequate breathing. The respirator collar was well padded to eliminate friction. The foot board was solidly fastened and the feet held snugly against it so there would be no appreciable head to foot shifting and, in case of a sudden stop, the patient's head would not be drawn through the head collar.

Before the transfer was made the glass respirator mirror was replaced with a polished metal mirror so that the patient could observe his surround-

ings from the open end of the truck. This was helpful in preventing apprehension, and patients found the trip interesting rather than frightening.

With the patient in readiness and his respirator in perfect running order, with all the accessory equipment — such as suction and oxygen supply — ready, with the electric generator and outlets in order, with the physician and nurse ready to go with the patient, with the convoy all assembled, then only was the patient moved from the ward. An extension cord was used to operate the respirator as it was moved to the elevator. It was pumped by hand in the elevator, and an extension cord provided current on the way to the truck.

A short-handled bar for hand operation was constructed for the Drinker-Collins respirator so that this operation would not be hampered by the limited space in the elevator, doorways or on the truck.

The respirator was cautiously pushed up, feet first, onto the truck over a portable inclined ramp. Both the patient and the respirator gauge were watched carefully to prevent a leak from developing as a result of the jarring during moving.

The convoy consisted of the truck, a police car and a fully equipped ambulance. The truck was equipped with a red light and a siren. Traffic was cleared by the police car; the truck and then the ambulance followed. The ambulance carried special emergency equipment — a resuscitator, suction apparatus and a 200 foot waterproof cable. Thus provision was made so that if the truck should break down, there should be an accident or the respirator should completely fail, even for hand operation, the patient could still be taken out of the respirator, given artificial respiration with the resuscitator and moved by ambulance.

When the convoy left the hospital, the receiving hospital was notified of the expected minute of arrival.

Using prearranged hand signals, the physician accompanying the patient could transmit commands to the personnel in the ambulance. They, in turn, using lights, could signal the truck and the police car to slow down or to stop.

It was not always possible to use the same personnel in the convoy with each transfer. Consequently, the driver of the lead car was always furnished with a detailed map of the route, indicating the speed over each section, the intersections of special danger, etc. Through traffic a speed of 36 miles per hour was maintained by the use of sirens on the cars preceding and following the ambulance truck, and on the open highway speeds of from 45 to 48 miles per hour were feasible. The route of the transfer had been carefully gone over to eliminate rough roads, narrow bridges, railroad tracks, busy intersections and other hazards which might slow down the convoy.

Respirator patients who could tolerate breathing alone for four or five hours were usually moved by ambulance and were accompanied by a doctor and a nurse, who were responsible for oxygen, suctioning and resuscitation procedures if indicated. The receiving hospital made arrangements to place the patient in a respirator immediately on arrival.

Results

With use of these precautions and procedures 80 patients were moved distances varying from 13 to 50 miles. All arrived at their destination in good condition and none suffered any delayed ill effects from the transfer. Though a few had some temporary discomfort from the jolting, especially of the abdomen, most patients enjoyed the ride. One patient was moved

about 120 miles and although he was one of the most severely involved cases, he experienced no appreciable difficulty. In one instance the respirator failed completely just as the patient arrived at the receiving hospital and he was changed quickly into another respirator. This experience emphasized the importance of taking all possible precautions.

EDUCATIONAL THERAPY IN THE REHABILITATION OF THE TUBERCULOUS *

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Over two thousand years ago Plato,[1] in reporting the conversation of his mentor, Socrates, quoted him as saying to a young man who had a severe headache, "In treatment we must not separate the soul from the body." Critias, the young man's uncle, was said to have interrupted happily at this point, saying, "This headache will prove an unexpected benefit to my young relation, if the pain in his head compels him to improve his mind." This observation captures the essence of rehabilitation in tuberculosis. Instead of a sorry gap in his life history, the patient may enjoy a fruitful period by revamping his life to fit his disability while receiving definitive medical care.

To this end, educational therapy has proved of great importance. Its technic is simply the use of formal courses as instruments for medically supervised work therapy. These instruments are often courses accredited on high school and college levels, such accreditation serving to sustain the patient's interest by giving him tangible results in the form of end of course certificates, high school diplomas, college credits and entrance requirements to trade schools. This rather unfamiliar but nevertheless important armamentarium can serve the physician in his master therapeutic strategy which must be aimed not only at medical but also at social, economic and psychologic targets.

One concern in the physician's long range management of tuberculosis is vocational retraining, once the course of the disease is rendered favorable. In this respect, educational therapy becomes preventive medicine, since a prevocational foundation is laid for a medically desirable and productive livelihood, excellent assurance against subsequent relapse. A consideration early in the course of treatment is the corrosive effect of anxiety and tensions engendered by long periods of inactivity.[2] With a supervised study program constructive occupation replaces destructive preoccupation with self and thus

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1. Plato: Charmides.

2. Dietrich, J. E.; Whedon, J. D., and Shorr, E.: Effects of Immobilization upon Various Metabolic and Physiologic Functions of Normal Men, Am. J. Med. 4:3 (Jan.) 1948.

promotes more nearly complete physiologic rest. A third contribution to the total care of the patient by educational therapy may be in the form of psychotherapy. The patient is given an opportunity to discover that, despite his disability, his wage-earning capacity has not been destroyed, thus dispelling the feeling of depression, ostracism and inadequacy which tuberculous patients often harbor. Fourthly, educational therapy provides a laboratory in which the patient's personality and mental and physical capacities may be explored under a realistic work situation. A fifth contribution of educational therapy to total rehabilitation rests in the enrichment of his life by developing and extending avocational interests.

It is by no means implied that these five objectives exhaust all the possibilities of educational therapy, but they do represent those most frequently encountered in practice. They can best be amplified by the presentation of the following case histories.

Most outstanding is the use of educational therapy as a preventive measure, i. e., prevention of relapse by means of prevocational training aimed at the final goal of a medically desirable vocation. Under this heading one may have to consider the possibility of converting a patient's occupation.

J. M., a 25 year old man, was hospitalized for two years for moderately advanced tuberculosis. He had been contributing to the support of his family since he was 14. While working as a laborer in the day, he was attempting to complete his high school education at night. This program undoubtedly contributed to his illness. Tests showed an I. Q. of 137 and a high aspirational level. After the period of complete bed rest, the patient worked with the educational therapy section of the department of physical medicine rehabilitation. On a gradually increasing and medically supervised schedule, he completed high school work as well as work toward college entrance. He is now planning to attend one of the major colleges for a degree in business administration.

J. M. used his hospital time to lay the foundation for a new occupation. When his vocational conversion is complete, he not only will have satisfied the medical necessities of the situation but will have achieved a socioeconomic level commensurate with his innate capacities.

A variant of the objective of vocational conversion is illustrated by the following case:

J. B., a 23 year old man, was hospitalized for one year for moderately advanced tuberculosis. Previously, he had supported a wife and two children as a clerk, his low income being supplemented by relief allotments. This patient was found to be functioning at an I. Q. of 128 and to possess a definite flair for mathematics. While hospitalized he completed courses on a college level in mathematics and physics and satisfied college entrance requirements with honors. He won, in addition, a scholarship on the basis of both his work with the educational therapy section and his excellent potential for completing the vocational goal established in the hospital. He is attending an engineering school at present.

Although this patient already had a suitable occupation from a medical viewpoint, by conversion he took steps to gain both a better standard of living and the satisfaction derived from full realization of his potential.

In line with ultimate vocational rehabilitation, educational therapy may be used as a means of ensuring continuity of effort toward completion of previously established vocational goals which are medically feasible.

C. O., a 28 year old man, was hospitalized for six months for far advanced pulmonary tuberculosis. After unsuccessful pneumothorax collapse therapy, the disease was finally arrested by thoracoplasty. He had started a full time course of study in accounting prior to hospitalization. At the proper time he was assigned to classes in bookkeeping, typing and business arithmetic. Upon discharge he was able to return to school and resume his work with minimal loss of accomplishment.

The patient bridged the gap between prehospital and posthospital life by carrying on his chosen life pattern, thus increasing his chances of taking his place as a productive member of his community with minimal loss of time.

Another vocational objective during hospitalization lies in the enhancement of previously acquired skill, which may afford the patient a higher standard of living when he finally returns to his job.

W. G., a 34 year old man, was hospitalized for twenty-one months for moderately advanced tuberculosis. He had been employed as a clerk by the board of education. On the basis of his work with the educational therapy section, he acquired a high school diploma and additional educational experience which he had been unable to achieve before. When he returned to work, these accomplishments enabled him to qualify for an immediate promotion, with its accompanying financial reward.

This man's scholastic achievements had medical significance, for it is conceivable that the rise in his standard of living will provide a more healthful enrivonment and thus minimize the possibility of reactivation of his disease.

In addition to its use in the field of vocational rehabilitation, educational therapy, as any appropriate work therapy, can promote physiologic rest. Properly graded activity may make bed rest more tolerable, particularly to hyperactive patients, and relieve mental and physical tensions.

H. P., a 27 year old clerk, was hospitalized for one year for minimal pulmonary tuberculosis. This patient, very active in his prehospital life, complained of restlessness when put on complete bed rest. Because he was "getting tired doing nothing," his physician allowed him suitable work according to his interests. He began studying for a high school diploma. This work provided an adequate channel for his energies, and he no longer complained of restlessness and tension.

It may be assumed that the possible hazard of the small amount of activity was more than balanced by the benefit derived from this patient's acceptance of bed rest. His activity, moreover, yielded the important by-product of accomplishment toward an ultimate vocational goal, for with the reward of a high school diploma he was stimulated to consider further academic training.

Another use of educational therapy is to provide supportive therapy in the treatment of the patient by the psychiatrist. In a tuberculous patient, as in one with any chronic disease, one often has to combat feelings of hopelessness and inadequacy. The development of self-confidence and self-esteem as a result of achievement contributes immeasurably to the patient's ultimate socioeconomic rehabilitation.

C. P., a 23 year old man, was hospitalized for two years for far advanced chronic pulmonary tuberculosis, which was finally controlled by pneumothorax. The patient was a linoleum cutter who had completed three years of high school. Because of his disease, he showed signs of extreme depression, felt that he was a "leper" socially and vocationally and expressed disbelief in his ability ever to head a family. All these factors were important considerations in the over-all therapeutic regimen. A suitable vocational objective was first chosen. A feeling of self-confidence was instilled in the patient on the basis of his performance in mathematics, English and bookkeeping. Study was carried out by means of individual tutoring and in class groups. The achievements of other patients in his group and of former patients who were actually earning a livelihood after discharge from the hospital were all included as factors in his treatment. By the time of his discharge he had become interested enough to complete his high school education.

By the use of educational therapy as a psychotherapeutic medium the patient was relieved of his feeling of ostracism and was aided in making a successful readjustment to posthospital life. At present, he is in college majoring in accounting. As further evidence of complete rehabilitation, he is engaged to be married in the near future.

Because the classroom provides a realistic work environment, it may often be utilized as a laboratory to observe certain mental and physical aspects pertinent to the over-all management of the tuberculous patient. Find-

ings so obtained by a trained educational therapist may materially aid the doctor in his clinical evaluation of a patient's personality and capacities.

A close study of the following patient's performance record first revealed the need for psychotherapy.

B. H., a 21 year old man, was hospitalized for seven months for tuberculous pleurisy. His previous occupation had been that of a counterman, his father's vocation also. During hospitalization, he was assigned to educational therapy to complete his high school education. His minimal productivity did not correspond to his expressed interest; yet for three months any suggestion to discontinue activity was met with strong protestations. His record showed irregularity of attendance, poor work, inability to receive constructive criticism and help and poor group participation. For these reasons, he was referred to the clinical psychologist, who found the patient to be an immature individual functioning on an I. Q. level below his capacity. It was felt that this situation was due to a heavy anxiety overlay, stemming from an unstable home situation, in which the patient resented his father and stepmother because he felt that he was being exploited by them. Collaboration between the educational therapist and the clinical psychologist resulted in the formulation of a long range plan for his admission to an advanced school of dietetics. This gave the patient motivation for a more nearly satisfactory adjustment in the hospital. No adequate follow-up is available, since the patient has just been discharged.

It is obvious that daily contact with the patient gives an alert therapist clinical opportunities which other members of the staff may not enjoy. Equally as important as daily contact is the very nature of the work, which enables the therapist to derive valuable information concerning the patient.

Educational therapy may also be used to give a patient an insight into his interests and aptitudes by means of a realistic situation.

R. L., a 23 year old man, has been hospitalized for one year for pulmonary tuberculosis. The patient, who had been a radio repairman, had not completed high school. His wife at present is hospitalized for tuberculosis. An additional handicap was his unfamiliarity with the English language. He expressed a strong and determined interest in the secretarial-bookkeeping field. Working along these lines, he soon realized that his interest and capacity in detail work were not commensurate with his expressed desires. He started, consequently, allied background work for a post office position, an occupation he plans to enter upon discharge.

This patient was faced with the problem of supporting himself and his wife, upon whose help he could not rely. Putting his plans to a test while in the hospital enabled him to save valuable time that he would have lost by embarking upon training in an unsuitable field. More important, however, is the fact that, by eliminating a field of work which he might not have pursued to completion or in which he would not have succeeded, the patient probably avoided superimposing the trauma of failure upon his original disability.

In further elaboration of educational therapy as a test device, it may be said that in all cases the clinical findings of the educational therapist materially aid the doctor in evaluating the patient's work tolerance. In anticipation of discharge, the patient is subjected to a "hardening process" by progressive upgrading of activity. In this process the therapist becomes an observer, who records his capacity for sustained activity as reflected in signs of fatigue, flagging of interest and caliber of the prepared lessons. The patient is thus allowed to work at a level compatible with his given condition and is guarded against continuing should his clinical status change for the worse.

Finally, guidance in activity on an avocational plane is another function of educational therapy. Enrichment of basic interests of the patient, even though it may not be for economic goals, contributes to the development of his total personality and adds to the enjoyment of life. This is not the least consideration from the point of view of complete rehabilitation.

All the objectives of educational therapy which have been discussed are obviously interrelated in almost every case. It is merely for the sake of clarity that certain groupings have been selected to illustrate the significance and efficacy of this modality. For example, the "hardening process" is inseparable from prevocational exploration or avocational pursuits. The establishment of new work habits may be related to the psychotherapeutic effects of all work activity. Any one or all of these factors may have to be considered in relation to the total personality pattern of the patient during the administration of the broad rehabilitation aspect of purposeful educational therapy. This interrelationship is borne out by the assertion of a well known educator and philosopher,[3] that the fully adjusted and well rounded individual has four facets to his personality to be developed — vocation, avocation, family group membership and community group membership.

At whatever educational level or with whatever complexity of purpose work activity be administered, the educational therapy unit, as an integral part of the rehabilitation program, provides a therapeutic means of aiding in the prevention of relapse. It assists the patient to restore himself to that degree of complete personal and economic security which will be within the limits of his physical capacity. It enables him to attain through achievement that self-confidence which makes for a useful and active life. In short, to paraphrase Plato, his disease may "prove an unexpected benefit" if the lesion in his lung compels him to reorganize his life.

3. Ratner, J.: John Dewey's Philosophy, New York, Random House, Inc., 1939.

AMBULATION OF PATIENTS WITH SPASTIC HEMIPLEGIA *

Further Observations

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Attending Physiatrist, Physical Medicine Rehabilitation Service,
Birmingham Veterans Administration Hospital
LOS ANGELES

and

CLEMENT C. TROENSEGAARD, M.D.
Acting Chief, Physical Medicine Rehabilitation Service,
Birmingham Veterans Administration Hospital
VAN NUYS, CALIF.

It has been noted that elevating the sole and heel of the shoe worn on the normal foot of a patient with spastic hemiplegia is a definite aid in ambulation. This alteration of the shoe is not a substitute for the brace. Instead, it is a supplementary aid to the use of the brace. Its effectiveness lies in its inhibitory action on the extensor spasm of the involved leg. This effect is manifested by decreasing the positive support reaction and stretch reflexes, thereby allowing for greater ease in the swing-through of the involved leg and for more adequate use of residual voluntary action. An equally important effect is on the center of gravity. In walking, it is not necessary to shift the center of gravity so far beyond the normal in order to lift the affected leg when the body weight is carried on the

* Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are the results of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

unaffected lower extremity. Since weight bearing on the hemiplegic side is encouraged the center of gravity is shifted more toward the normal when the body weight is borne on the involved leg. The end result is a smoother gait and greater stability.[1]

To check the effectiveness of a lift on the normal foot, 15 patients with spastic hemiplegia who were wearing a drop foot brace were tested. They were tested in a consecutive, unselected order as they appeared on the roster for gait training at Birmingham Veterans Administration Hospital.

It was found difficult to classify these patients into grades of ambulation; 3 of them were capable of ambulation without canes, and the remaining 12 were forced to utilize canes for support. The effectiveness of the procedure was determined by improvement of the gait in relation to balance. The ability to discard the cane was not accepted as a criterion of improvement. It was found that when a lift was added to the unbraced shoe 9 additional patients were capable of ambulating without a cane. Their performance was improved even further when they had the supporting effect of the cane. In many of these cases, only slight pressure was placed upon the cane during walking. In 2 patients, the cane was carried more for psychologic support than for stability.

To determine the amount of elevation necessary, blocks of wood which covered the bottom of the sole and heel of the shoe were used. The thickness of these wooden lifts varied from ¼ to ¾ inch. They were strapped on to the shoe worn on the normal foot by means of adhesive tape. By having the patient ambulate while wearing the various blocks of wood the proper elevation was determined. It was found that one could judge the effects upon the centers of gravity and also the ability to clear the ground with the involved leg. However, the step of the normal leg was stiff and unnatural. Therefore, the smoothness of the gait was not taken as a criterion; instead the effect upon the centers of gravity and ability to clear the ground were the factors determining the proper elevation.

As mentioned, the use of a block had a definite disadvantage. It did not allow for the normal bending in the sole of the shoe during the step. Consequently, the foot was held rigid. To overcome this, a more satisfactory and natural testing method was used. This consisted of the use of boards of the same thicknesses as the wooden blocks. These boards were 12 feet in length. The patient could walk with the normal foot on the board and the involved foot on the floor. This allowed for normal use of the unaffected foot. Also, one could more readily visualize the effect upon the smoothness of the gait and upon the centers of gravity which would take place when the lift would be added to the unbraced shoe. In spite of the deficiencies of the former (block) method, it can be used as an office procedure where space may not allow for the use of long lengths of board or as a home procedure where carrying long lengths of board would be impracticable.

In all 15 cases tested a definite improvement in gait was noted. The improvement was immediate. With additional gait training, even greater agility in ambulation was accomplished.

1. Yamshon, L. J.: An Aid to Walking in Patients with Spastic Hemiplegia, Arch. Phys. Med. 31:158, 1950.

ARCHIVES of PHYSICAL MEDICINE

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL MEDICINE

EDITORIALS

THE CHANGING ORDER

The report of the Rockefeller Foundation for 1949 by Chester I. Barnard contains a statement which illustrates clearly the trend away from support of higher education by private foundations and toward governmental subsidizing of such education.

Doctor Barnard reports: "Until recently The Rockefeller Foundation was a principal source of funds for foreign student fellowships at the advanced level. Today, as shown by the United Nations Educational, Scientific and Cultural Organization handbook of available fellowships, *Study Abroad*, appointments made annually by the Foundation constitute hardly 2 per cent of the 15,070 comparable awards now offered, 62.5 per cent of them by government agencies." Doctor Barnard adds: "As things stand now, the income of The Rockefeller Foundation, the General Education Board and the Carnegie Corporation covers less than 1 per cent of the budgetary needs of the 1,800 institutions now ministering to higher education. Indeed, the annual expenditures of all foundations, even though roughly $100,000,000, are insignificant in relation to public and private funds now needed and now available for education, scientific research and scholarly activities."

Not only is the support from private philanthropy for medical education and for health and welfare fading into insignificance as compared with the enormous support now being offered by governmental agencies but also various voluntary health and welfare agencies are finding it increasingly difficult to compete with governmental programs. Recently Basil O'Connor, while President of the American Red Cross and of the National Foundation for Infantile Paralysis, warned that unless private agencies assume a positive attitude, he could "see no hope for their survival" and he added, "When taxes take the place of free will giving that is based on individual choice, one responsibility that is the basic element in our way of life will have been lost."

It is evident that we are facing a changing order and that increased taxation is limiting the private philanthropies of the great foundations possessing huge funds provided by the vanishing group of multi-millionaires and of the huge foundations possessing almost equally large sums which have been obtained by mass voluntary contribution of "the kiddies' dimes." Whether we like it or not, we are facing a changing order. We should probably be sufficiently liberal in our views to want to see in this changing order developments which will continue to provide better health and educational facilities for all even in the face of certain sacrifices of personal liberties but most physicians are still sufficiently reactionary to believe that our capitalistic free enterprise system should not be destroyed in this changing order. It is to be hoped that we can find a happy compromise somewhere between the capitalism of Diamond Jim Fisk and the communism of Joe Stalin. It is to be hoped that in this changing order, our nation will not shift too far to the left. The success of the American Medical Association program in combating the passage of a national health act indicates that we may be able

to find a happy center ground in this changing order. All physicians should be aware of these developments and their possible effect on the practice of medicine. All physicians should be striving to maintain, within this changing order, the best features of the free enterprise system which is the very essence of the American democratic way of life.

MEDICAL NEWS

Meeting on Physical and Mental Rehabilitation

The annual meeting of the Association for Physical and Mental Rehabilitation was held at the Hotel Peabody, Memphis, Tenn., May 23-27. The following papers were presented: "Teaming for Rehabilitation," Alvin B. C. Knudson, Washington, D. C.; "Functional Bracing," Robert L. Bennett, Warm Springs, Ga., and "Medical Aspects of the Neurologic Patient," by Ben L. Boynton, Houston, Texas.

Nursing Problems of Poliomyelitis

A conference on the diagnosis and clinical management and nursing problems of poliomyelitis was held in Enid, April 11-12, under the sponsorship of the Garfield-Kingfisher County Medical Society. The conference was planned by the office of Postgraduate Instruction, Oklahoma University School of Medicine. Dr. Thomas Gucker of the Children's Hospital, Boston, was the guest speaker and moderator. The first day of the conference was devoted to a discussion of diagnosis and clinical management of poliomyelitis and the second day to nursing problems associated with care of patients with poliomyelitis.

Advanced Course in Physical Rehabilitation Methods for Physical Therapists

A special four week course is offered by the Institute of Physical Medicine and Rehabilitation of the New York University-Bellevue Medical Center in conjunction with New York University School of Education.

Dates: for school year 1950/51.
November 27-December 22, 1950.
January 8-February 2, 1951.
April 9-May 4, 1951.

Course Description

Course 180.431 Advance Course in Physical Rehabilitation Methods for Physical Therapists. The course is divided into three sections:

I. Severe Disabilities and Their Rehabilitation: All aspects of orthopedic, medical, surgical cases and their specific problems in rehabilitation are discussed. The lectures and demonstrations are given by physicians, rehabilitation and other medical specialists. Instructors: Dr. H. Rusk, Dr. G. Deaver, Dr. D. Covalt, associates, staff of the Institute of Physical Medicine and Rehabilitation and guest lecturers.

II. Skills and Methods of Functional Activities: Theory, technic, teaching methods, tests and individual programs of Functional Activities will be discussed, demonstrated and practiced. Clinical observation will be included. Instructor: E. Buchwald, M.A., A.P.T.A.

III. Clinical Experience: Students will work with patients under supervision at the Institute of Physical Medicine and Rehabilitation. Instructor: E. Buchwald and staff.

Course Details

Requirements: Open to Certified physical therapists who have the approval of the Curriculum Director.

Credit: Four points of either undergraduate or postgraduate credit.

Hours: Mondays, Wednesdays, Fridays, 9:00-4:00 P. M.

Tuesdays, Thursdays 9:00-5:30 P. M.

Fees: Tuitron $62.00 ($15.50 per point); Registration, $3.00. Qualified Veterans may enroll in the course under the provision of P. L. 346 or P. L. 16.

Housing: Arrangements have been made through the Institute for rooms in nearby hotels at $13.75 to $18.00 per week.

Application: Applications and requests for further information may be submitted to Miss Edith Buchwald, Director of Rehabilitation Courses for Physical Therapists, Institute of Physical Medicine and Rehabilitation, 325 East 38th Street, New York 16, New York.

Apparatus Accepted

National Light Duty Cautery Set — Designed for eye, nose, throat and dental use. The Council on Physical Medicine and Rehabilitation voted to include the model in its list of accepted devices.

I. M. A. Thermocouple — Skin thermometer housed in a wooden case consisting essentially of a galvanometer connected with one interior and one exterior junction of dissimilar metals. The Council on Physical Medicine and Rehabilitation

voted to include the apparatus in its list of accepted devices.

Astar'te Two-Way Stretch Elastic Stocking. — Provides steady pressure over large areas of the leg, useful in treatment of varicose veins. The Council on Physical Medicine and Rehabilitation voted to include the Astar'te Elastic Stocking in its list of accepted devices.

Newman Expansometer. — Device designed for use in measuring chest expansion of patients, especially those in whom there is unequal movement of the two sides. The Council on Physical Medicine and Rehabilitation voted to include the Newman Expansometer in its list of accepted devices.

Airco Oxygen Therapy Regulator, Nos. 806-8480 and 806-8482. — Two-stage regulators equipped with gages for indicating both rate of flow of oxygen and residual-cylinder content. Both are provided with safety valve for relieving excessive pressures. The Council on Physical Medicine and Rehabilitation voted to include these devices in its list of accepted apparatus.

Fairchild-Huxley Chest Respirator. — Cuirass respirator consisting of one pump, three cuirasses and one vacuum hose. This respirator does not take the place of a tank type respirator and is accepted only as supplemental equipment. The Council on Physical Medicine and Rehabilitation voted to include the apparatus in its list of accepted devices.

Armour Insufflator. — Small device designed for inhalation of medicaments which can be put into the device in the form of powder and then aspirated in the form of an aerosol or dust. The Council on Physical Medicine and Rehabilitation voted to include the Armour Insufflator in its list of accepted devices.

Newly Registered Technicians

July 3, 1950

Beck, Pauline W., 158 Westbrook St., S. Portland, Me.
Bussiere, Phyllis M., 3 Vine St., Northfield, Vt.
Cleverly, Jeanne M., 27 Maryland St., Dorchester 25, Mass.
Crider, Mary J., Potomac Ave., Extended, Hagerstown, Md.
Dolan, Margaret A., 72 Concolor Ave., Newton, Mass.
Griffith, Diana G., 16 Chauncy St., Apt. 46, Cambridge, Mass.
Gustafson, Lois P., 130 Beverly Rd., Worcester, Mass.
Hardee, Mrs. Jane, 24 Page St., Malden 48, Mass.
Hickey, Helen K., 35 Maple St., Watertown 72, Mass.
Isham, Mary F., 2014 Hillhurst Ave., Los Angeles 27, Calif.
Johnston, Joan P., 102 Central Parkway, Mt. Vernon, New York.
Kelly, Patritia K., 9 York Rd., Lynn, Mass.
Kenyon, Elaine K., Hendrick Mem. Hosp., Abilene, Texas.
Knapp, Nan C., 15-A Mechanic St., North Easton, Mass.
Lacer, Mrs. Viola H., 4146 Rainbow Blvd., Kansas City, Kan.
Langley, Celeste B., 2202 N. Beachwood Dr., Hollywood 28, Calif.
Mokrycki, Mary J., Windsor Locks, Conn.
Moran, Pauline T., 57 Ackers Ave., Brookline, Mass.
Morse, Patricia A., 3 Jackson St., Newburyport, Mass.
Ouellette, Rita A., 442 Richards Ave., Portsmouth, N. H.
Pope, M. Carolyn, 16 Florence St., Hudson, Mass.
Pylka, Martha H., 165 Trenton St., Pawtucket, R. I.
Reeve, Esther R., Hutchison St., Flossmoor, Ill.
Salisbury, Amy M., 326 Colorado St., Bend, Ore.
Shields, Barbara M., 17 Park St., Newton, Mass.
Sullivan, Marie D., 21 Osborne St., Peabody, Mass.
Whitney, Nancy A., 25 High St., Winchendon, Mass.

July 27, 1950

Bartlett, Priscilla A., 112 Central St., Foxboro, Mass.
Bateman, Nancy A., 23 Sheffield Rd., Melrose, Mass.
Bowman, Nancy Clarke, RFD 1, Naugatuck, Conn.
Buchanan, Brenda L., 61 Hillside Rd., Franklin, Mass.
Hale, Sally L., 1109 W. Forest Rd., Lakewood, Ohio.
Hastings, Jeanne E., 610 Wilton Rd., Towson, Baltimore, Md.
Jacobs, Elaine E., 342 Belmont St., Fall River, Mass.
Munroe, Mrs. Dorcas P., S. Main St., New Canaan, Conn.
Oblmann, Kathleen G., 215 Lawndale Ave. N. E., Grand Rapids, Mich.
Piermarini, Elva G., 31 Brown St., Leominster, Mass.
Secor, Joan M., 28 Meadoway, Dobbs Ferry, N. Y.
Wilson, Joan C., 156 Sheridan Terr., Ridgewood, N. J.
Zink, Bernice H., 141 Pratt, Fitchburg, Mass.

August 1, 1950

Albano, Helene, 353 E. Oneida, Preston, Idaho.
Bolton, Norma G., Box 13, Cardiff, Calif.
Carper, Mr. Emery C., Gen. Dely., % L. Beckworth, Weston, Ore.
Carter, Eileen L., 121 Woodrow Ave., Oildale, Calif.
Eastmond, Mr. Robt. M., Saratoga Resort, Lehi, Utah.
Fleissner, Mr. Pierre, 765 Temple, Apt. 7, Long Beach, Calif.
Fletcher, Mrs. Dorothy L., 618 Tudor Rd., San Leandro, Calif.

Forward, Edna M., P. O. Box 6, Pope Valley, Calif.
Green, Mr. Robt. G., 981 S. 10th East St., Salt Lake City, Utah.
Hamilton, Dorothy E., 1200 Boswell, Topeka, Kas.
Heick, Mary H., 170 Albert, Waterloo, Ont., Can.
Larson, Rebecca A., Robinson, Kas.
Law, Mary J., 854 Kirby Place, Shreveport, La.
McKillip, Mrs. Ardis J., 2552 W. 63rd St., Chicago, Ill.
McKillip, Mr. James B., Jr., 2552 W. 63rd St., Chicago, Ill.
Porter, JaNeva I., RR 2, McLeansboro, Ill.
Rainbolt, Mr. James A., 2400 El Camino Real, Mountain, Calif.
Stewart, Lettie, E., 5809 Seville Ave., Apt B, Huntington Park, Calif.
Taylor, Mr. Howard G., Bowen, Ill.

The American College of Physicians Announces Its Annual Session at St. Louis April 9-13, 1951.

The American College of Physicians will conduct its 32nd Annual Session at St. Louis, Mo., April 9 to 13, inclusive, 1951. Dr. Ralph Kinsella of St. Louis is the General Chairman and will be responsible for local arrangements and for the program of Clinics and Panel Discussions. Dr. William S. Middleton, President of the College, Madison, Wis., will be in charge of the program of Morning Lectures and afternoon General Sessions.

Secretaries of medical societies are especially asked to note these dates and, in arranging meeting dates of their societies, to avoid conflicts with the College Meeting for obvious mutual benefits.

Million Lire Prize for Article on Rheumatic Diseases

An international contest for an original and unpublished article on the physiopathology, clinical history, and therapy of rheumatic and arthritic diseases is being sponsored by the Azienda Autonoma of the Health Resort of Acqui, Italy. A prize of one million lire will be awarded. Papers must be submitted by December 31. Further information can be obtained from the Azienda Autonoma Di Cura Acqui, Piemonte, Italy.

Radio Programs

"Health Talk," the weekly series on health education televised over WGN-TV, Chicago, under the auspices of the Educational Committee of the Illinois State Medical Society, will present the following programs during April:

April 4, The Second Child Arrives, Lawrence Breslow, Chicago.

April 11, The Rh Factor, Israel Davidson, Chicago.

April 18, Metal in Your Bones, Joseph Farrington, Chicago.

April 25, It's Your Heart, Andrew C. Ivy and Louis Krasno, Chicago. Dr. Theodore R. Van Dellen, Assistant Dean, Northwestern University Medical School appears as moderator in these weekly series of the Educational Committee.

Personals

Dr. Henry W. Woltman, Chief of the Neurology Section of the Mayo Clinic, has been appointed a member of the National Advisory Mental Health Council.

A General Electric X-Ray official has received outstanding recognition from one of the nation's well-known colleges recently, with the award of an honorary Doctor's Degree in view of his major contributions to science.

He is E. Dale Trout, assistant to the Vice-President, who was honored by his alma mater, Franklin College, at Franklin, Ind., from which he received his Bachelor of Science Degree in 1922.

He is particularly well known for his studies of the physical characteristics of radiation from beryllium-window tubes, which have made possible the production of x-rays of phenomenal intensity and range of wavelength.

At the annual meeting of the West Virginia State Medicine Association, July 27-29, Greenbrier, White Sulphur Springs, Dr. Howard F. Polley spoke on the following subject: "Investigations with Cortisone and Related Hormones in Rheumatoid Arthritis and Related Diseases."

Research in Rheumatology and Climatology

During the last annual meeting of the Swiss Society for Physical Medicine and Rheumatology, Swiss physicians heard an interesting report from an American physician, Dr. M. Curry, who is now in Bayern (Germany) and whose studies have caused much comment in the German and Swiss medical press. According to Dr. Curry the oxidation power of atmosphere is the essential climatic factor.

During the same meeting Professor Boni (Zurich) presented a report on the clinical applications of ultrasonics. Interesting therapeutic results have been obtained in rheumatic diseases and in sciatica due to radicular irritability without any syndrome of compression.

Arthur S. Lippmann

It is with regret that we announce the death, July 5, of one of our Congress members, Dr. Arthur S. Lippmann, of Sydney, Australia.

BOOK REVIEWS

LIGHT THERAPY. By *Richard Kovács*, M.D., Professor of Physical Medicine, New York Polyclinic Medical School and Hospital. Fabrikoid. Price, $2.25. Pp. 112. Charles C Thomas, Publisher, 301-327 East Lawrence Avenue, Springfield, Ill., 1950.

It is always a pleasure and privilege to review a book of Dr. Kovács. The publisher's choice in selecting Dr. Kovács for this book is recognition of his knowledge and experience. He is recognized as an international authority on this subject.

This monograph is a short review of the fundamental information on infrared, visible and ultraviolet radiation including the physics, physiology and clinical application of these physical agents. Only the most salient points are given, omitting many of the controversial ideas.

Every physiatrist will want a copy for his library. It should be valuable to other individuals in physical medicine and for physicians generally who want a clear and up to date work on the essential factors of light therapy.

This is an important and timely contribution in this popular lecture series.

PROCEEDINGS OF THE FIRST ANNUAL SYMPOSIUM ON ORTHOPEDIC APPLIANCES. Pittsburgh, Pennsylvania, September 20-26, 1948. Editorial Board, *A. S. Glushien*, M.D., Veterans Administration Hospital at Aspinwall; *W. A. Hamor*, Sc.D., Assistant Director, Mellon Institute, and *G. H. Young*, Ph.D., Assistant Director, Mellon Institute. Paper. Pp. 308, with illustrations. Published by the Orthopedic Appliances and Limb Manufacturers' Association, Washington, D. C., in cooperation with the Sarah Mellon Scaife Foundation, in appreciation of the Foundation's philanthropic efforts in behalf of that industry, through its Multiple Fellowship on Orthopedic Appliances at Mellon Institute in Pittsburgh.

This is a report of the lectures, demonstrations and discussions of the first symposium on orthopedic appliances held at the Mellon Institute in Pittsburgh under the joint auspices of the University of Pittsburgh Medical School and the Mellon Fellowship on Orthopedic Appliances. More than one hundred bracemakers, physicians and physical therapists were invited to attend this meeting. The lectures were designed to bring out the need and principles of braces for many types of disorders with demonstrations of their application. Other lectures dealt with the basic engineering subjects of construction, design and material which included the latest development in steel fabrication and heat treatment, brazing, welding, casting, metal finishing, use of alloys, textile materials, etc.

The fine address given by Dr. H. Worley Kendell of the University of Illinois Medical School at the dinner meeting is included in which he outlined the concepts and application of occupational therapy, physical therapy and rehabilitation.

The discussions following each lecture or demonstration are given. These are valuable since they show the practical and technical problems the bracemakers have in meeting the medical conditions. A thought that is frequently repeated throughout the book is the need for closer cooperation between the bracemaker and the medical profession.

This is not a reference book or the most complete work on braces and other orthopedic appliances, however, it should be helpful in a better understanding of the more technical problems. Certainly physiatrists, who should know as much if not more than any other physician about orthopedic appliances, will benefit by reading this book.

MEDICAL PHYSICS. Volume II. Editor-in-Chief, *Otto Glasser*, Ph.D., F.A.C.R. Diplomate in Radiological Physics, American Board of Radiology; Professor of Biophysics, Frank E. Bunts Educational Institute; Head, Department of Biophysics, Cleveland Clinic Foundation; Consultant, U. S. Veterans Administration, Washington, D. C. Associate Editors, All Contributors to Volumes I and II. Editorial Assistant, Jessie C. Tucker, Cleveland, Ohio. Fabrikoid. Price, $25.00. Pp. 1227, with illustrations. The Year Book Publishers, 200 E. Illinois St., Chicago 11, Ill., 1950.

The appearance of volume I of Glasser's "Medical Physics" in 1944 was a major event among the publications in medical physics, both because of the variety of interests represented in the book and because of the high quality of the contributions. In the six years that have elapsed this book was introduced it has been used very widely as a reference and standard work. It was a very fortunate idea of the editor to add this volume II rather than produce a second edition of volume I. Some of the articles in volume I are still up-to-date, and in the second volume they are simply mentioned as a referral to volume I. Other articles have been rewritten in volume II, and new articles have been added. Volume I and volume II together give an excellent review of the different activities which together form medical physics. In a book of this scope it is, of course, impossible to have all articles of the same outstanding value or of the same use to every user of the book. Some of the articles, such as the articles on plastics and photography, deal with technical methods employed in medical physics.

Others, such as the article by Burr on bioelectricity and the article by Curtiss and Cole, on excitation and propagation of nerve, deal with highly theoretic subjects in basic physiology or biophysics. Every one of the articles contribute to the outstanding total of information which is available in this momentous volume.

Among the articles that are not specifically labeled Physical Medicine are numerous ones which are valuable to the physiatrist, including a whole sequence of articles on aviation medicine which contain many points of interest in such fields as heat exchange, excessive temperature and oxygen lack.

Excitation in nerve has been described by Curtis and Cole. In this article they give an excellent review of the basic physiology of nerve excitation. It is unfortunate that when it comes to clinical application of their physiologic data in electric shock and clinical electrodiagnosis the material has been simplified to such an extent as to be of little practical value. Diathermy is covered by one short paragraph, in which it is mentioned that "it is a happy coincidence that this type of current penetrates the skin readily and is distributed uniformly throughout the underlying tissues."

An article of considerable value to all physiatrists who have to deal with poliomyelitis particularly bulbar poliomyelitis, is the article by Earl H. Wood on oximetry. An extensive bibliography accompanies this excellent review.

The value of "Medical Physics" is that it gives an "all over" reference to the material which is available in this very rapidly developing field. Obviously many of the subjects discussed in the book are available elsewhere in considerably greater detail, but every worker in the field of medical physics owes a vote of thanks to Dr. Glasser for a tremendous amount of work that must have been involved in bringing out these two volumes and giving us an overall survey of the different methods and results available in the field of medical physics. The book should be in the library of every physiatrist, every institution of physical medicine and every physiologist interested in the physical aspects of medical science.

ELECTROTHERAPY AND ACTINOTHERAPY. By *E. B. Clayton*, M.B., B.Ch. (Cantab.). Consulting physician to the Physical Treatment Department, King's College Hospital, London. Cloth. Price, $3.00. Pp. 460 with illustrations. The Williams & Wilkins Company, Mt. Royal and Guilford Aves., Baltimore 2, 1949.

This is a book written as a textbook for students of physical therapy. The author has previously written two books on the subject and he states the present volume is an amalgamation of these prior publications but with certain sections rewritten.

The book is divided into three parts. Part one deals with electrotherapy; part two discusses actinotherapy; and part three is headed "Treatments."

This is a text that is written from the British point of view and much of the subject matter will have little interest in this country. The first 147 pages are devoted to physics and while on an elementary level is well done. Many of the illustrations are excellent. There is a chapter on the dangers with electrical treatments. In this country the problem of whether electrical apparatus is earth-free does not arise as it apparently does in Great Britain.

It is to be regretted that the author uses such terms as ionization instead of the more accurate and descriptive term of ion transfer. It is noted that the term indifferent electrode is still retained. The term sinusoidal is too loosely used and the term is not fully defined. A chapter is devoted to the reaction of degeneration and diagnostic procedures such as the condensor method of testing; chronaxie; the strength-duration curve; and electromyography. There is a brief outline on the physics of high frequency current. Both long wave and short wave diathermy technics are not as fully covered as they need to be for class room teaching. However, the physics though limited is well presented.

The section on actinotherapy including infrared is meager but adequate for its intended purpose. Under treatments chapters are given to joints, muscles, and bones, diseases of the nervous system, tuberculosis and skin conditions, and miscellaneous conditions. The book is written in simple understandable language, but is just another book not too profound in its presentation. It is, however, suitable for elementary students if the material to be studied is chosen by a well informed instructor. Not one reference is given in the entire volume for the student.

CLINICAL RADIATION THERAPY. Edited by *Ernst A. Pohle*, M.D., Ph.D., F.A.C.R., Professor of Radiology and Chairman, Department of Radiology in the University of Wisconsin, Madison, Wisconsin. Second edition. Cloth. Price, $15.00. Pp. 902 with illustrations. Lee & Febiger, 600 Washington Square, Philadelphia 6, 1950.

Clinical Radiation Therapy is the second edition of Clinical Roentgen Therapy. In order to increase the usefulness of this volume it was decided to add radium therapy wherever feasible hence the change in title. The writers have placed emphasis on the strictly clinical aspect of radium therapy. Clinical Radiation Therapy is ably edited by Dr. Ernst Pohle, professor of radiology at the University of Wisconsin. There are fourteen chapters each written by a specialist in the field under discussion. The names of the twenty contributors reads like Who's Who in Radiology. This volume will be a most valuable reference work for all those engaged in all forms of radiation therapy. The beginner in this field will also need this text as a companion in his practical training course.

The subject is thoroughly covered and well presented with a wealth of illustrations. There

is an excellent and rich bibliography placed at the end of each pathology under discussion so that the reader may pursue the subject more fully if he desires. The chapter subjects are radiation therapy in the following diseases: the blood and blood forming organs; the circulatory system; respiratory system and of the breast; the gastro-intestinal tract; the female genital organs; malignant diseases of the genito-urinary tract; the nervous system; the eye and ear; the muscles, bones, joints and tendons; and dysfunctions of the glands of internal secretion; inflammatory diseases; and the skin. There is an excellent chapter on radiation reactions and injuries written by MacKee and Cipollaro and this chapter should be read by all physiatrists. The authors discuss ultraviolet irradiation as a prophylactic for radiodermatitis as well as its place in the treatment of chronic ulcers and sequelae. The use of ultraviolet irradiation is considered in the treatment of telangiectasia. Another excellent chapter by Donaldson is on the civil liability of the radiologist. The book closes with two supplements: one is devoted to low intensity radium needles; and two to dosage calculation in radium therapy. This volume should have a wide appeal to all radiologists. It is well written and easy to read. It is highly recommended.

PAVLOV: A BIOGRAPHY. By *B. P. Babkin*. Cloth. Price, $6.00. Pp. 365, with 8 illustrations. The University of Chicago Press, 5750 Ellis Avenue, Chicago 37, Cambridge University Press, Bentley House, 200 Euston Rd., London, N. W. 1; W. J. Gage & Co., Ltd., Toronto 2B, 1949.

This is a most stimulating and fascinating book written by Pavlov's senior surviving pupil. Babkin knew Pavlov well for thirty-five years and served as his assistant in the Department of Physiology at the Institute of Experimental Medicine in St. Petersburg. This association developed into a lasting friendship. Perhaps no one is more able at this time to give an account of the life and scientific achievements of this great Russian physiologist and world famous scientist.

The book is divided into four parts. Part one deals with Pavlov's biography from his birth to his death and the author's reminiscences of Pavlov. Babkin traces Pavlov's humble origin and devotes considerable attention to the influence of Pavlov's wife and the many men who helped to mould the career of this great man. The author asks, "With what yardstick can one measure Pavlov as a man? If he had been an ordinary man, he would be considered an egoist, for whom personal interests were of such paramount importance that everyone and everything had to serve him. However, such a yardstick cannot be applied to a man of genius. Pavlov served an ideal of the highest and noblest character. He did not require much, the simplest life satisfied him completely." Pavlov was not only an honest and independent person but a fighter by nature.

Part 2, 3 and 4 deal with his scientific achievements in the physiology of the cardiovascualr, digestive, and central nervous systems.

Dr. Babkin has rendered a great service in presenting this biography. It is written in a comprehensible style so that the work will be enjoyed by the intelligent lay reader. It is to be hoped however, that this work will be read especially by the young embryo in science no matter what his field of endeavor may be. This work should prove a real inspiration to all those who have the least interest in scientific medicine and its related fields. This book is highly recommended. It is a fascinating story.

NEW DISCOVERIES IN MEDICINE: THEIR EFFECT ON THE PUBLIC HEALTH. By *Paul R. Hawley*, M.D. Cloth. Price, $2.50. Pp. 134, with illustrations. Columbia University Press, 2960 Broadway, New York 27, 1950.

This book offers the second annual series of Bampton Lectures in America given by Dr. Paul R. Hawley, a physician of thirty years service in the U. S. Army Medical Corps, and Chief Surgeon in the European theater from 1942 to 1945; subsequently he has done outstanding work as chief medical director of the Veterans Administration, then became chief executive of the Blue Shield and Blue Cross Commissions and is now director of the American College of Surgeons. This background will explain the subjects boldly chosen and ably expressed in these lectures. The first lecture, "Our Fabulous Blood," explores some ancient superstitions about blood, and underlines its unsurpassed importance as a curative agent—a fact which has tended to be somewhat obscured by the discovery of the antibiotics and other potent drugs. He describes the blood and plasma program of World War II and its role in the saving of tremendous numbers of battle casualties, and devotes an entire chapter to a discussion of the RH factor and its effect upon pregnancy and childbirth. A section on "Modern Surgery of the Heart and Lungs" is concerned with the amazing progress in thoracic surgery and is illustrated with photographs of actual operations. "Modern Prevention and Treatment of Mental Disease" offers invaluable information from Bedlam to thalamotomy, psychotherapy, shock therapy and psychosurgery, including such modern topics as prefrontal lobotomy, topectomy and thalamotomy. The lecture presents an account of the economic aspects of medical care, and current methods for coping with increased costs, which the author ends with the earnest statement that with the inadequate amount of knowledge upon the subject that he has at this moment, he is opposed to compulsory health insurance. He asserts that thus far, the half-truths and the palpable misstatements that have been advanced to support this radical innovation have failed to convince him, and while he recognized the existence of deficiencies, he knows of none that can be corrected without a radical change in the pattern of medical care — a pattern which has accomplished so much and which continues to raise quality.

CLINICAL ELECTROENCEPHALOGRAPHY. By *Robert Cohn*, M.D., Electroencephalographer and Director of Neurological Research, U. S. Naval Hospital, Bethesda, Maryland. First edition. Fabrikoid. Price, $14.00. Pp. 639 with illustrations. McGraw-Hill Book Company, Inc., 330 W. 42d Street, New York 18, 1949.

Doctor Cohn bases his book on his experiences with 10,000 patients over a twelve year period.

The contents include a general discussion; an origin of brain potentials, technic, classification, etc.; normal range; tumors; cerebral vascular lesions; hypertension; encephalopathies; head injuries; epilepsies; headaches; sleep; alcoholism and drug reaction; and, disorders of behavior.

The technic reads well and is quite lucid. The correlation between amplitude and electrode placement is well put. The theory is simply put in physical electronic terms.

For normal controls, 251 apparently healthy corpsmen were examined. In terms of population, this is a small number but agrees with previous analyses. It should be emphasized that 14 per cent of the normals had minimum to maximum abnormalities.

Doctor Cohn suggests that the E. E. G. interpreter be present while the technician works on the patient, thus being able to correlate better the electrical with the clinical signs. Although theoretically plausible, it is highly impractical and, furthermore, the E. E. G. should be an objective electrical test. It either is normal or abnormal.

Although a larger bibliography would be of help with more current literature, the seventeen references are well chosen and refer to the best past literature and to sources of up-to-date references.

There is very little given on common electrical artifacts.

All in all, this book is a valuable contribution and should be a part of every electroencephalographer's and E. E. G. technician's library. It is of definite use as a reference to all interested in this specialty.

REHABILITATION, RE-EDUCATION AND REMEDIAL EXERCISE. By *Olive F. Guthrie Smith*, M.B.E., F.C.S.P. (Hon.), T.M.G. Formerly Principal of the Swedish Institute, London, and of the Physical Exercise Dept., St. Mary's Hospital, London, W. 2. Vice-President of the Chartered Society of Physiotherapy. With a foreword by Lord Horder, G.C.V.O., M.D., F.R.C.P. Second Edition. Cloth. $6.00. Pp. 456, with 283 illustrations. The Williams & Wilkins Co., Mount Royal and Guilford Rd., Baltimore, 1949.

This work originally appeared in 1943. It has had two reprintings plus this new edition, all of which attests to its well justified popularity. Although the author's title might be considered her 3 R's, it is really a book on voluntary exercises. The effort is to secure function by any means possible as long as it requires work on the part of the patient. This may be minimal in which various forms of assistive apparatus are used or it may require as much strength as possible. The author stresses the idea of working "with the patient" and not "on the patient."

The famous suspension apparatus is explained in detail. This type of exercising is widely used in England and strongly advocated abroad. The weight and counter weight of the body is utilized to secure the resistive type of exercises. Physiologically the method appears sound and the use of relatively simple apparatus seems to be practical. It seems strange that this means of securing exercises has not been given a greater trial in this country.

Many short chapters cover various subjects, for example, joint manipulation is contributed by Dr. Mennell in which he outlines his principles and technic; rehabilitation by games shows what can be done with a heavy ball to promote exercises; physiotherapy and the puerperium in which a routine set of exercises is given for the successive days; rehabilitation in the chest unit is written by several authors on pre- and post-operative thoracoplasty, empyema, asthma and others; recovery after fractured femur written by Dr. Corkin in which he gives in detail the exercises, not only for the individual hip muscles but general exercises as well; and numerous other good chapters. Less worthy are the chapters on occupational therapy, electrotherapeutic unit and massage in which methods and their application are proposed that might well be questioned.

Not all statements will go unchallenged and numerous forms of therapy are recommended which have been found wanting when tested critically but these do not counteract the many valuable suggestions.

This edition adds new chapters on the care of the arthroplasty of the hip, osteoarthritis of the hip and rehabilitation after injuries to the spinal cord.

All who read the first edition of this book were impressed with the wealth of material it covered. This second edition includes all the ingenious and practical suggestions for exercises found in the first edition plus several new ideas.

THE MERCK MANUAL OF DIAGNOSIS AND THERAPY. A Source of Ready Reference for the Physician. Eighth edition. Fabrikoid. Prices, regular edition $4.50, thumb-index edition $5.00. Pp. 1592. Merck & Co., Inc., Rahway, New Jersey, 1950.

This popular manual has been thoroughly revised and contains an amazing amount of up-to-date therapeutic information and in particular the use of modern chemotherapeutic and antibiotic agents. Although one might assume that drug therapy would be emphasized, physical therapy is described in better detail than in many standard texts on the practice of medicine. Recommended as a valuable therapeutic index for the general practitioner.

PHYSICAL MEDICINE ABSTRACTS

Treatment of Poliomyelitis. Earl C. Elkins.

Kentucky M. J. **48**:136 (March) 1950.

The concept of treatment of poliomyelitis is now fairly well established, although technic varies in minor ways. The major aim of active treatment of poliomyelitis is to salvage what remains of the function of the weak and paralyzed muscles. None of the treatments used, for example, supportive, physical, or orthopedic treatment, has any effect on the progress of the disease; nor can treatment change the already existing primary lesions in the central nervous system.

During the past decade, because of an apparent increase in incidence of the disease, and an undoubted increase in accuracy of diagnosis, interest in treatment has been augmented. It is evident, however, that not enough physicians in widely scattered, small hospitals are prepared to organize and supervise treatment through all phases of the disease. In many epidemic areas, where emergency technical help has been allocated, this personnel has been expected to examine patients and to evaluate and prescribe treatment for the neuromuscular involvement in a large percentage of cases. Medical supervision often has been superficial and has consisted of irregular visits of a physician from a distant center.

The clinical phases of poliomyelitis usually are divided into three stages: acute, convalescent and chronic. In treatment of acute poliomyelitis, supportive measures are those used in any infectious disease. Emergency procedures, moreover, sometimes are necessary to save the patient's life. In this connection careful observation of the patient for respiratory difficulty is important.

Measures should be taken, in cases in which paralysis is present, to provide proper support of the extremities and to maintain correct bodily alinement. Rigid supports may be used but not as substitutes for good care.

The mechanism by which frequently applied hot packs relieve the pain of poliomyelitis and cause muscular relaxation is not known. Neither is it known whether the moist heat of the hot pack has any advantage over other forms of heat. The method of applying packs has changed considerably. The meticulous procedure of applying hot packs to the various segments of the body is not as widely used now as previously. In the past several years, use has been made of the so-called prone pack although the patient may be either prone or supine. At all events, in the majority of cases of poliomyelitis, if proper treatment is given, the pain, tenderness and muscular tightness usually disappear in two to eight weeks. It should be recognized, however, that in many instances heat alone will not eradicate the muscular tightness.

Passive stretching exercises, if carefully done following theromotherapy, are important.

Treatment after the acute stage (fourteen to twenty-one days), in addition to attempting to relieve pain and muscular tightness, should have as its aim the establishment of coordinated muscular function.

Methods used do not differ greatly from those which have been employed for many years. However, compared with former times, more emphasis has been placed on this training and it is carried on for a longer period.

As muscular strength returns and coordinated motion is established, the activities of the patient are increased.

In training a patient who has extensive poliomyelitis, it is necessary to bear in mind that, in addition to trying to increase muscular strength and bring about the best possible function of the remaining muscles, the patient must be physically rehabilitated to the greatest possible degree. Frequently little or no guidance is given the patient relative to his future life. This is left to the family or to a social agency. These patients must be treated as a whole, as any severely handicapped patient is treated, and treatment can be considered a partial failure if this is not done. The patient's family, in most instances, cannot adequately finish rehabilitation of the patient.

Poliomyelitis usually is considered to have become chronic after recovery from weakness or paralysis has ceased.

The final stage of treatment consists of (1) permanent use of orthopedic appliances, and (2) correction of deformities and production of stabilization by surgical means.

Conservative Treatment of Functional Disorders of the Feet in the Adolescent and Adult. R. Plato Schwartz, and Arthur L. Heath.

J. Bone & Joint Surg. **31-A**:501 (July) 1949.

Pronation in childhood is an expression of deficiency in the function of the intrinsic osteoarticular structures of the foot. By application of the principles of Wolff's law, pronation may be greatly improved or entirely eliminated by the time the child is sixteen. In both children and adults, the preservation of function of the intrinsic and extrinsic structures essential to normal stance and locomotion is required for maximum efficiency and greatest freedom from discomfort. The shoes in which feet must work constitute the major cause of these problems common to successive generations. Excellence in quality of footwear cannot assure that the feet will be free from functional impairment. The structural and functional relationship between foot and shoe is determined by the last over which the shoe is made.

The design of lasts has been determined by a combination of empirical influences, without benefit of measurements necessary for the preservation of function of the intrinsic and extrinsic structures essential to efficiency and comfort in stance and locomotion. Full understanding of the needs of the human foot in action awaits the further application of measurement to the study of foot dynamics. Proved principles can then replace opinion in the design of shoe lasts and in the application of therapeutic measures.

Physical Medicine in General Practice. Sedgwick Mead.

Postgrad. Med. 7:54 (Jan.) 1950.

A few conditions are illustrated which are among the commonest encountered in a physical medicine practice and which give the most gratifying results to treatment. Equipment is simple.

Even more important than the equipment are the services of a skilled assistant. Beware the pitfalls of employing receptionists and other persons to administer treatments about which they know nothing.

An ideal arrangement for a group medical practice would be to pool resources for equipment and hire a physical therapist. Be sure she is registered by the American Registry of Physical Therapy Technicians. This will insure that she trained at a school meeting the minimum requirements of the Council on Medical Education and Hospitals of the American Medical Association. It will also insure that she is an ethical medical aide who does not illegally practice medicine on her own.

Write detailed and intelligent prescriptions. Do not expect the physical therapist to make diagnoses or assume too much responsibility for the objectives of treatment. She is there to carry out the details accurately and safely.

Power Exercises in Medicine. George Darwin Wilson.

South. M. J. **43**:29 (Jan.) 1950.

Power exercises supersede time consuming active and passive exercises. These exercises are the final step of physical rehabilitation and give a definite yardstick for the statement that maximum medical benefits have been reached.

There is discussed the value of using power exercises as a method of evaluating efficiency of medications that usually are evaluated by the patient's statement of well being or can be evaluated by expensive and elaborate laboratory procedures found only in the large hospital centers.

Once a neuromuscular unit begins functioning much wasted time on passive or active exercises can be avoided by using power exercises.

Power exercises are prescribed as home care follow through to office practice by use of inexpensive apparatus such as a bar-pulley-weight adjustable to any door frame in the home. By testing in the office the number of weights that can be added for an arm or leg, the patient can continue prescribed power exercises at home. Of interest is the fact that an added weight of 3 to 5 pounds in a pocketbook hung on the paralyzed flexed hand assists walking, often without crutches or a cane.

In incomplete paraplegia resistive exercises may be the physical procedure to permit ambulation progressing to independence with or without braces, crutches or canes.

Power exercises are a physical adjunct to the maximal recovery in the shortest time of some arrested or reversed pernicious anemia cases.

Rehabilitation of peripheral nerve injuries especially following surgery by physical therapy modalities is gratifying and the prognosis is good. Resistive exercises play the climaxing role in the final recovery.

Power exercises in chronic poliomyelitis complete the physical management and continue where muscle reeducation, passive and active exercises leave off. Prescribing heavy resistive exercises is guided by muscle testing and may be started on a muscle graded 2 or fair.

Power or progressive resistive exercises offer a valuable means of evaluating the efficiency of a medicine. These exercises are especially valuable in measuring physiologic effects of medicines that act directly or indirectly to improve muscular strength or are administered to relieve muscle spasm. In neuromuscular conditions some medicines are administered empirically without a means of evaluation other than the patient's own statement of his general condition. In addition to evaluating the efficiency of a given medicine these exercises may be a means of determining the sufficiency of dosage.

Medications administered in peripheral vascular diseases may be evaluated by resistive exercises. Besides measuring the distance walked by a patient with peripheral vascular disease before intermittent claudication begins after a given medicine, the plantar-flexors, hip flexors, or knee flexors may be measured in pounds of weight lifted before cramping. A larger number of weights lifted gives an index of the medicine's efficiency.

Bracing for Cerebral Palsy. Winthrop M. Phelps.

Crip. Child **27**:10 (Feb.) 1950.

It must be remembered that cerebral palsied children never have learned the fundamental motions of the arms, legs, tongue and the rest of the body.

The child who has had some condition present either from birth or shortly after never had an opportunity to learn any of the fundamental patterns. This child differs greatly from the child who previously learned the patterns and then lost them through a paralytic disease of one sort or another.

One method of training in these primary patterns consists of starting with the simpler patterns, and working up to the more complicated ones.

This is the essential of treatment, actual education. "Reeducation" does not accurately describe the process; and although "physical education" has

other implications, that is what it consists of. These children, rather than being educated physically from a given point to a higher point of skill are educated from a very low primitive point of skill, up to, we hope, the normal level.

There can be no substiute for this education, and it is done under four general headings: physical therapy, which teaches arm and hand skills; speech therapy; and the use of apparatus. The latter, sometimes called functional therapy, teaches the child actual activities rather than primary motions. But the other three steps, of course, have to precede it.

In carrying out this program it is necessary to give the child as much help as possible, so we have three general groups of what might be called adjuncts to treatment—braces, drugs and surgery. All are useful in certain instances and in certain types, but all definitely are not useful in other types.

In summary, two main types of braces, the control and corrective braces, are used as aids or adjuncts in the rehabilitation of the cerebral palsied child. The part they play is definitely the part of an adjunct to treatment: they should be used only when very definitely indicated.

The Diagnosis and Treatment of "Mechanical Backache." George S. Phalen.

J. A. M. A. **141**:445 (Oct. 15) 1949.

Before making the diagnosis of "mechanical backache" the physician must evaluate carefully the patient's history, the results of physical examination and roentgenograms of the lumbosacral spine. No one of these three items must ever be omitted. The diagnosis of "mechanical backache" indicates that there is no actual disease or permanent structural abnormality which is responsible for the backache.

Heat aids in the relaxation of the back muscles and stimulates circulation. The patient is advised to take a hot tub bath nightly, remaining in the water for a period of five to ten minutes. This should be followed by a twenty to thirty minute period of application of local heat, an infrared lamp or a heating pad being used. It is not advisable to sleep on the heating pad all night. A few minutes of gentle massage over the back muscles may then be given by some other member of the patient's family, but this massage is not an essential part of the treatment. The patient then performs the series of exercises which have been prescribed by the physician and in which he or she has been carefully instructed. It is not enough to advise a patient to take exercises. The patient must be shown exactly how to perform the exercises, and the description of the exercises should be written down and given to the patient for ready reference. The patient is told not to attempt to do too many exercises at first because of the danger of overtaxing the already weakened back musculature. If possible, the exercises should be done both morning and night. It is imperative to do the exercises at least once every day.

There are listed simple postural exercises for most cases of "mechanical backache."

Back muscles are strengthened only by exercise and not by the wearing of a support. The wearing of a brace for a long period of time delays the permanent cure, although the immediate effect may be beneficial.

The most common type of low back pain is the "mechanical backache," caused by some alteration in the normal body balance. This balance may be upset by certain mechanical factors such as faulty posture, obesity, relaxed abdominal musculature, weak back musculature and inequality of length of the lower extremities. Because a "mechanical backache" is seldom incapacitating, the physician is apt to minimize its importance, and the patient consequently seeks treatment from someone outside the medical profession. If the general practitioner will diagnose this condition, he can institute a program of treatment that will effect a cure.

Posture. J. T. Aitken.

Brit. J. Phys. Med. **12**:92 (July-Aug.) 1949.

Posture is the attitude or carriage of the body. Observation of people standing in queues or on stations shows that the human body is carried in a great variety of ways, and that in any individual there is a constant change. Within a few minutes, the weight is carried down one leg then the other or down both legs. The way in which the nonweight-bearing leg is used for balancing purposes also varies, as do the positions of the hands and arms. At one moment the body is held erect and on the alert, and the next moment it is allowed to relax and slouch. In view of all this change, it is desirable to recognize certain well-known attitudes of the body. When the person is "standing at attention" he has his heels together, the weight is evenly distributed down both legs and the arms are placed at the sides of the trunk. Usually the body leans forward slightly and almost all the muscles are taut. Much energy is used in this attitude, which is rarely found outside military life. The "stand-at-ease" position allows of some relaxation of the muscles from the "attention" position; the heels are separated and the forward leaning of the body is reduced. The weight is again transmitted down both legs, and this is the usual attitude of a person on the alert in civilian life. In the "stand-easy" position, the weight usually is carried by one leg, the other being used to help to balance the body, and little energy is expended, for most muscles are relaxed and at rest.

The Use of Ultrasonic Pulses for the Measurement of Biologic Tissues and the Detection of Tissue Density Changes. J. J. Wild.

Surg. **27**:183 (Feb.) 1950.

Ultrasonic waves, as their name implies, are sound waves of very high frequency. They behave in a manner similar to that of other types of sound waves in that their speed of travel through media varies with the density of the me-

dia. Further, ultrasonic waves can be reflected by surfaces or interfaces to produce echoes. A method for measuring the thickness of the human bowel in situ in the living subject was sought, and the use of high frequency sound waves was deemed feasible. It is the purpose of this communication to describe the results so far obtained.

A method of measuring the thickness of biologic tissues by means of ultrasonic echoes is described. The method can be applied to the detection of changes in tissue density. The application of these principles to the detection of accessible tumors is discussed.

Is Relaxation an Active Process? A. V. Hill.

Proc. Roy. Soc. London, SB 136:120 (Oct.) 1949.

It is commonly believed that relaxation after contraction is an active process, that a muscle, having shortened, forcibly lengthens again. The proof that no heat is produced in relaxation by a muscle relaxing without load or tension, and that any heat found otherwise during relaxation can be attributed to degraded mechanical work, threw doubt on this belief.

In the first group of experiments described below the latent period was determined, over a range of lengths as wide as possible, on the short side of the resting length in the body. It was necessary, for accuracy, to avoid any influence of inertia, viscosity, stickiness, or capillarity; the muscle, therefore, was freely suspended in moist air, with an inextensible vertical connection to a rapid, frictionless isometric tension-recorder. It had to be allowed to shorten freely to any desired length, without any force, however small, which could pull it out again. Experiments showed that over a considerable range of lengths the latent period is practically constant; and that this range can be increased by previous stimulation, causing the muscle to draw up without subsequent lengthening. If active lengthening occurred during relaxation, its effect on the latent period of the next response would be very much greater than anything observed.

Electrophrenic Respiration.

Comment, Brit. M. J. 4650:426 (Feb. 19) 1950.

Artificial respiration can be given either by manual manipulation of the patient, by intermittent positive pressure, or by an "iron lung." Recently Sarnoff and his co-workers have developed a new method which depends on intermittent stimulation of the phrenic nerve. In experiments on cats and dogs the nerve was exposed and a silver electrode applied, an indifferent electrode being placed anywhere on the skin. A Grass stimulator supplied faradic stimuli at a rate of 40 per minute. The current was fed through a rotating potentiometer which in the course of each respiratory cycle gradually increased the voltage to three volts and then gradually reduced it. This stimulus gives a slow contraction of the diaphragm resembling the normal movement.

Electric Current Transients Through the Human Body. John W. Moore.

J. Applied Physiol. 2:355 (Dec.) 1949.

The passive electrical characteristics of tissue have generally been studied by the frequency response method of analysis. A network of two resistors and one condenser has often been proposed as giving an electrical response equivalent to that of the tissue studied. However, some more complicated and different networks have been proposed, such as a two condenser-four resistor one by Lullies. Cole has developed the method of the complex plane locus for frequency dependent impedances. This method includes the possibility of recognition of the condenser element as itself having frequency-dependent impedance.

Another method of study of the passive electrical characteristics is through the observation of the transient of current following the sudden application of a constant voltage. Gildemeister and Einthoven and Bijtel studied such transients with string-galvanometers. The frequency response of the galvanometer is much too poor to follow the rapid transients observed in tissue with any accuracy. Strohl and Hozowa made use of the ballistic galvanometer to give a point-by-point plot of the transient.

The passive electrical characteristics of human tissue have been studied by the method of the current transient associated with an abrupt voltage change. Photographs are taken of the transient pattern on an oscilloscope screen and are analyzed for characteristics exponential decreases in current with time. Two characteristic exponential current decay rates were found and a network giving the same type of transient is presented. The decay rates are shown to be relatively constant from person to person. A table is given to show the effect of variation of several factors involved.

It is postulated that a correlation between physiologic data of nerve and muscle excitability and their passive electrical characteristics may be found by the transient method.

Localizing Cerebellar Syndromes. Joe R. Brown.

J. A. M. A. 141:518 (Oct. 22) 1949.

Based on present concepts of cerebellar anatomy, there are five recognizable pure cerebellar syndromes. These have been described as the posterior lobe, vestibular complex, anterior lobe, generalized deficit and bilateral posterior lobe syndromes. In addition, there are three variant localizing syndromes which result from associated implication of cranial nerves and brain stem structures. Illustrative cases are cited, prognosis is indicated and the results of therapy are suggested.

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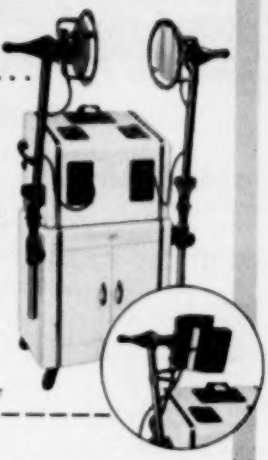

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United States Army							
Letterman General Hospital★ •	San Francisco	A. E. White	21,861	188,112	2	1/1, 7/1	n
†Fitzsimons General Hospital★	Denver	H. B. Luscombe	21,090	261,585	4	———	n
Army Medical Center★	Washington, D. C.	E. M. Smith	8,676	134,137	6	7/1	n
Veterans Administration							
†Veterans Admin. Hospital ‡	Ft. Logan, Colo.	F. J. Fricke	4,610	58,879	1	———	n
Veterans Admin. Hospital	Chamblee, Ga.	G. D. Williams	4,922	39,181	1	7/1	n
Veterans Admin. Hospital	Hines, Ill.	L. B. Newman	20,052	472,950	3	1/1, 7/1	n
Veterans Admin. Hospital	New Orleans	S. Winokur	1,107	49,815	1	7/1	n
Veterans Admin. Hospital ‡	Framingham, Mass.	F. Friedland	9,000	24,000	2	7/1	n
Veterans Admin. Hospital ‡	Jefferson Bks., Mo.	S. Mead	4,046	53,920	2	7/1	n
†Veterans Admin. Hospital ‡	New York City	K. Harpuder	12,613	279,817	3	1/1, 7/1	n
Veterans Admin. Hospital ‡	Cleveland	H. T. Zankel	2,452	105,000	2	7/1	n
†Veterans Admin. Hospital	Aspinwall, Pa.	S. Machover	1,993	62,792	1	7/1	n
†Veterans Admin. Hospital	Portland, Ore.	E. W. Fowler	4,395	96,766	1	1/1, 7/1	n
Nonfederal							
Los Angeles County Hospital★‡	Los Angeles	O. L. Huddleston	———	133,694	1	Varies	$165.00
White Memorial Hospital★	Los Angeles	F. B. Moor	33,606	———	—	———	120.00
Stanford University Hospitals★§	San Francisco	W. H. Northway	———	6,833	—	7/1	50.00
University of Colorado Medical Center							
Colorado General Hospital★‡	Denver	H. L. Dinken	2,322	25,088	1	7/1	75.00
†Emory University Hospital★	Emory Univ., Ga.	R. L. Bennett	9,648	20,206	1	7/1	50.00
†Georgia Warm Springs Foundation	Warm Springs, Ga.	———	859	1,108	2	———	———
Cook County Hospital★	Chicago	D. Kobak	3,357	33,282	—	1/1, 7/1	———
Michael Reese Hospital★‡	Chicago	C. O. Molander	1,007	19,443	1	Varies	25.00
Northwestern University Medical School	Chicago	———	13,286	34,813	—	———	———
†University of Kansas Medical Center★	Kansas City, Kan.	D. L. Rose	11,684	31,938	1	7/1	100.00
†Massachusettts General Hospital★	Boston	———	———	———	—	———	———
University of Minnesota Hospitals★‡	Minneapolis	M. Knapp	15,391	21,885	4	———	105.00
Mayo Foundation	Rochester, Minn.	F. H. Krusen	———	———	6	Varies	92.50
Barnes Hospitals★	St. Louis	———	820	10,951	—	7/1	25.00
†Bellevue Hospital, Div. III—							
New York University★	New York City	———	———	———	—	———	———
Goldwater Memorial Hospital★‡	New York City	———	2,799	124,357	—	———	———
†Hospital for Joint Diseases★‡	New York City	J. Weiss	70,070	93,036	1	7/1	40.00
Hospital for Special Surgery	New York City	K. G. Hansson	———	41,111	—	———	———
Montefiore Hosp., for Chronic Diseases★‡	New York City	K. Harpuder	———	———	—	———	———
Mount Sinai Hospital★	New York City	W. Bierman	———	———	—	7/1	50.00
New York City Hospital★‡	New York City	F. K. Safford, Jr.	955	26,418	—	———	———
†Presbyterian Hospital ★‡	New York City	W. B. Snow	70,406	191,021	2	1/1	41.66
St. Luke's Hospital★	New York City	R. Muller	1,202	126,904	1	7/1	50.00
†Rehabilitation Hospital ‡	W. Haverstraw, N.Y.	M. Hoberman	322	291,115	1	———	200.00
Cleveland Clinic Hospital ‡	Cleveland	S. G. Gamble	17,985	17,884	1	7/1	125.00
Hospital of the Univ. of Pennsylvania★	Philadelphia	G. M. Piersol	1,396	15,575	1	Varies	100.00
Philadelphia General Hospital★‡	Philadelphia	———	3,073	21,749	—	———	———
Medical College of Virginia, Hosp. Div.★	†Richmond, Va.	F. A. Hellebrandt	3,787	34,009	—	———	———
State of Wisconsin General Hospitals★‡	Madison, Wis.	H. D. Bouman	2,783	45,840	—	———	———

The star (★ indicates hospitals approved for training interns.
The dagger (†) indicates temporary approval.
‡ Residencies open to women.
§ Includes Fellowships.
n Salary established by government pay tables.

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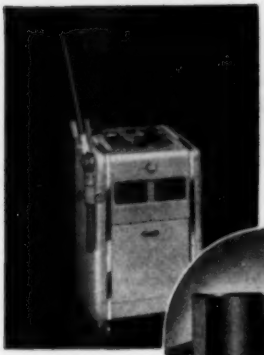

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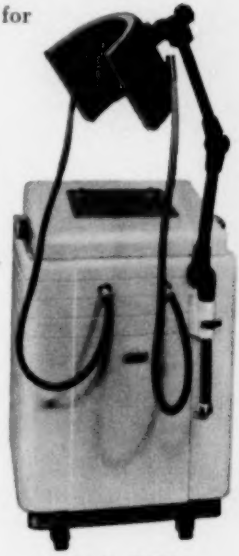

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